Design Report
Saline Effluent Treatment Plant (SETP)

6528-680-132-REP-003

Rev. 01

In Accordance with Licence 2AM-MEL1631 Part D, item 1 & 2

Prepared by:

Agnico Eagle Mines Limited – Meliadine Division

and

WSP Canada Inc.

DOCUMENT CONTROL

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Prepared By: melissa.simard@agnicoeagle.com

Signature numérique de melissa.simard@agnicoeagle.com
DN : cn=melissa.simard@agnicoeagle.com
Date : 2019.05.31 05:17:01 -05'00'

Melissa Simard
Construction Eng.

2019-05-28
Thomas Genty
Water Treatment Specialist

Dominique Richard, Eng.

Approved by: nancy.harvey@agnicoeagle.com

Digitally signed by nancy.harvey@agnicoeagle.com
DN: cn=nancy.harvey@agnicoeagle.com
Date: 2019.05.30 17:06:31 -04'00'

Nancy Duquet Harvey
Environment Superintendent

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1 INTRODUCTION

1.1 SITE LOCATION AND ACCESS

Agnico Eagle Mines Limited (Agnico Eagle) is developing the Meliadine Project (the Project), a gold mine located approximately 25 km north of Rankin Inlet, and 80 km southwest from Chesterfield Inlet in the Kivalliq Region of Nunavut. The project site is located on the peninsula between the East, South, and West basins of Meliadine Lake (63°01'23.8"N, 92°13'6.42"W). The area is accessible from the all-weather gravel road linking the Meliadine mine site with Rankin Inlet.

A general location plan for the project is shown in Figure 1.

1.2 SITE FACILITIES

The current mine plan focuses on the development of the Tiriganiaq gold deposit which will be mined using both conventional open-pit and underground mining operations. Current or proposed mining facilities to support this development include a plant site and accommodations, tailings storage facility and water management infrastructure.

Several infrastructures such as water retention dikes, berms, culverts, channels, collection ponds, pumping stations, fresh water intake and water treatment plants are required to manage water during pre-production, operations, and interim mine closure.

Facilities that are planned to be constructed for the operation of the Meliadine Mine include a process plant, power plant, maintenance facilities, tank farms for fuel storage, water treatment plant, sewage treatment plant, saline water treatment plant, saline effluent treatment plant (SETP) to treat water before discharge to the sea, accommodations, and kitchen facilities for 520 people.

Figure 2 shows the location of the SETP.

1.3 PURPOSE OF DOCUMENT

This report includes the final design and construction drawings for the SETP, including the pumping and piping. The water treated at the SETP will be sourced from underground mine. The effluent water from the SETP will be pumped in SP3 and transported by truck tanker to its final location for sea discharge at Itivia in Melvin Bay via an underwater pipe diffuser.

1.4 SCOPE OF WORK

WSP Canada was retained by Agnico Eagle to design the SETP, pumps, pipelines, and effluent water outfall to the discharge location. Veolia, H2Flow are the provider of the treatment unit within the SETP. This report describes the SETP, pumps and pipelines design. Construction drawings of the listed infrastructure are presented in Appendix A of this report.

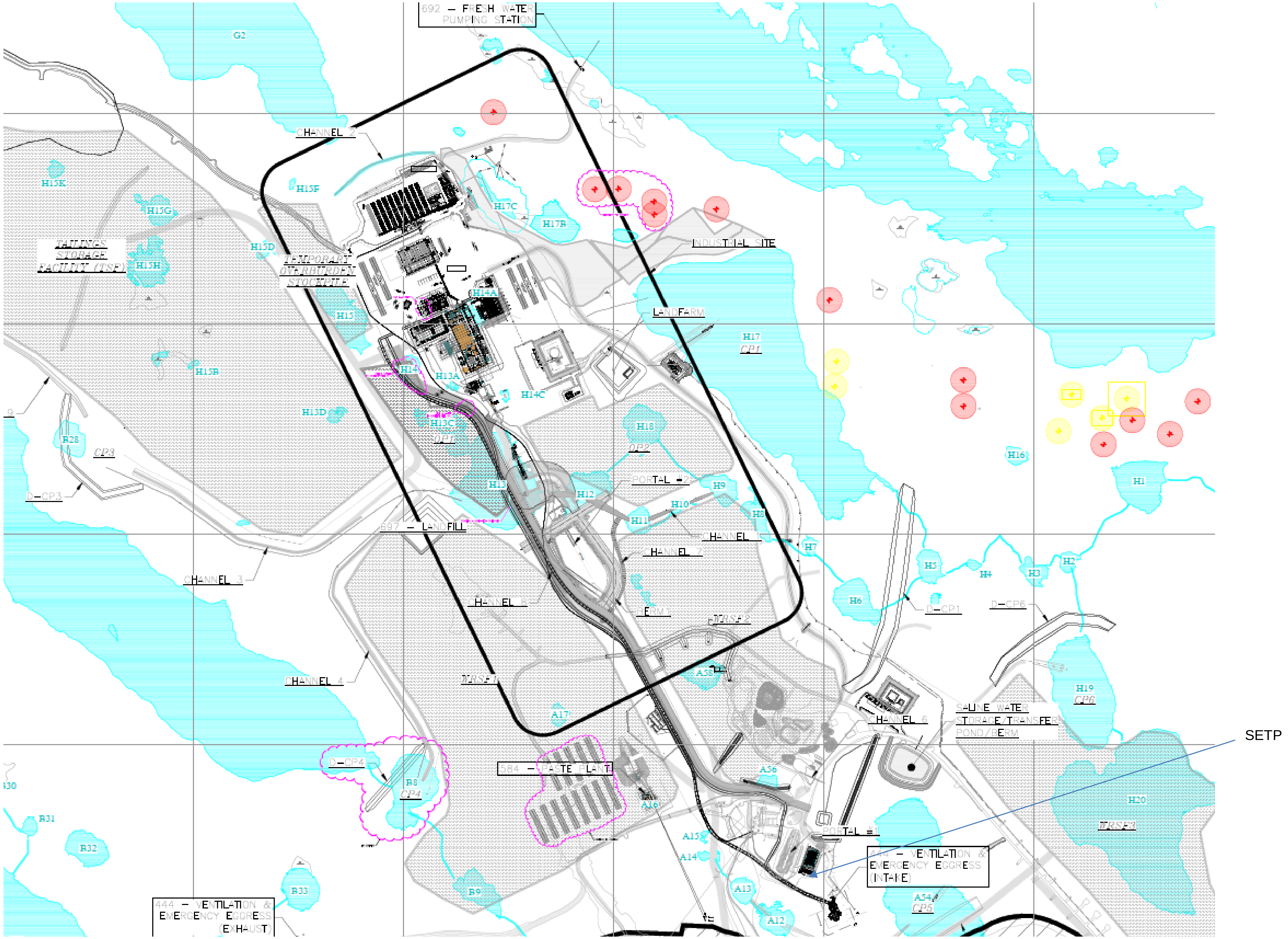

Figure 1 : General location plan

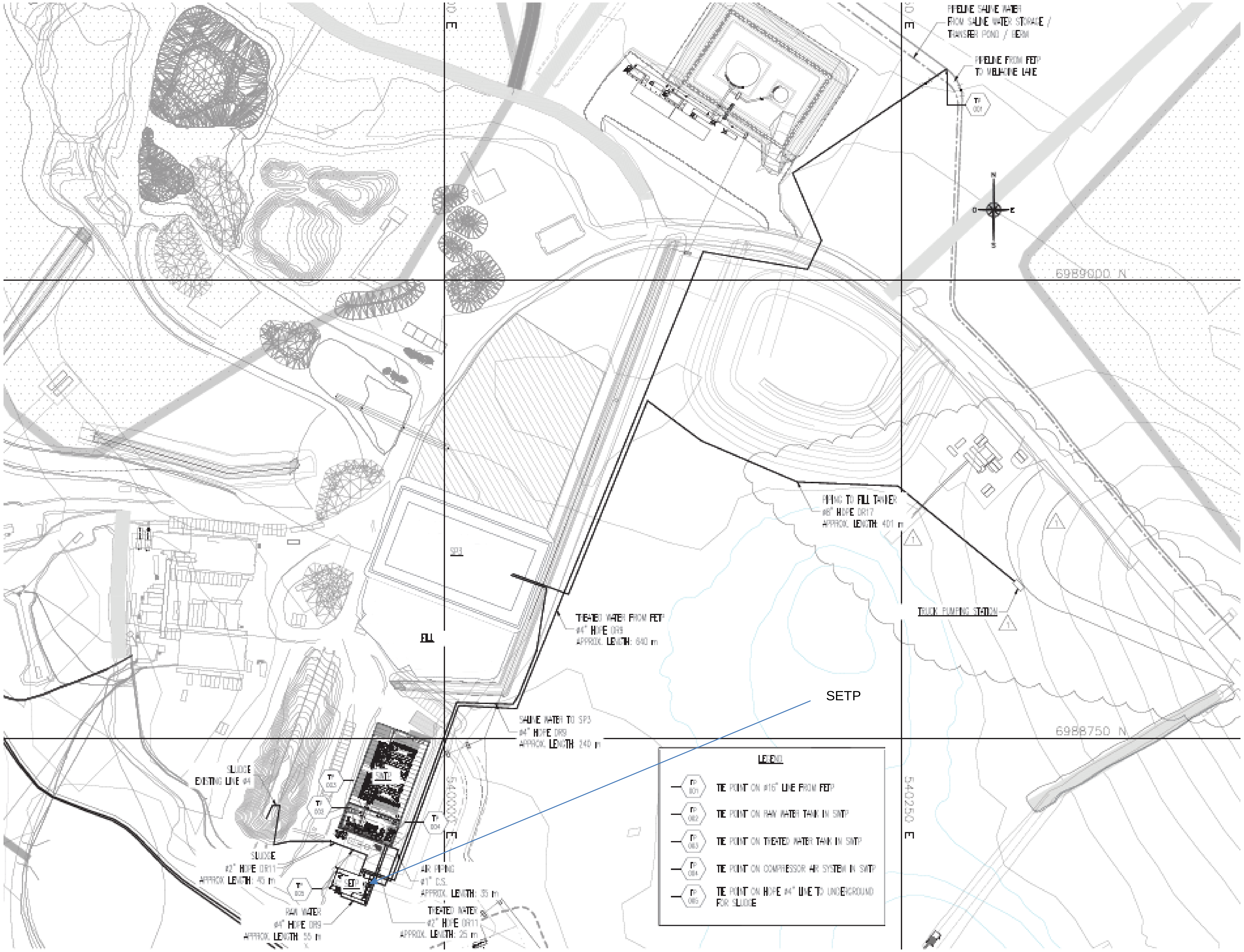

Figure 2 : Location of SETP

2 DESIGN METHODOLOGY

2.1 DESIGN RATIONAL, REQUIREMENTS, CRITERIA AND PARAMETERS

The design rationale are the following:

- Unit selected should be delivered and operational for summer 2019;
- Treatment performance of the SETP should comply with the regulatory requirement;
- Should minimize heating water;
- Should minimized production of byproduct (sludge for example);
- Simple to operate.

The contaminants of concern identified in underground water are: pH, Ammonia, TSS and oil and grease. The plant is designed to meet the following criteria presented in Table 1. Note that the treated water from SETP is not directly discharged to the environment. Water is discharged into SP3 pond (see design report 6528-680-132-REP-002, AEM, 2019).

Table 1 : Treatment Objectives of the SETP

Parameter	Unit	Limit average	Limit instantaneous	Type of limit
pH	-	6-9		regulatory
Ammonium	mgN/L	<5 mg/l		operational
Toxicity on marine species	-	Nontoxic		regulatory
TSS	mg/L	15	30	regulatory
Oils and grease	mg/L	5		regulatory

2.2 DESIGN STANDARDS ANALYSIS AND METHODS

Each component of the SETP was selected to achieve the requirement for the water quality of the SETP effluent. The selection of each of these components was based on a typical process used in the industrial water treatment sector. The robustness and redundancy of equipment were also taken into account during equipment/supplier selection.

2.3 DESIGN ASSUMPTIONS AND LIMITATIONS

The SETP is designed for a maximum treatment flow rate of 800 m^3/d. The design of the chlorination system is based on concentrations of ammonia of 120 to 330 mg/L and TSS of 200 ppm. However, the trend of ammonia concentration in underground water is decreasing, as such hypochlorite dosage would be readjusted during SETP commissioning. Indeed, dosage of hypochlorite is proportional to the ammonia concentration in underground effluent. Influent TSS concentration used for the design is estimated at 200 mg/L but better removal of TSS underground is expected with improving underground water management. The SETP is designed to allow the fluctuation of these concentrations.

2.4 SALINE WATER MANAGEMENT STRATEGY

Underground saline water is first treated underground for TSS through a Mudwizzard and decant basins and then transferred to the surface saline ponds (SP1 and SP2) which has a total storage capacity of approximately 111 000 m^3. From there, the saline water (from SP1/2 or underground stope/sump) will be transferred to the Saline Water Treatment Plant (SWTP) Raw Water Tank for treatment. Raw water feeding the SETP will be pumped from the raw SWTP water tank (level of water in this tank controlled with a level sensor). The storage capacity is managed to keep the saline pond and stope volumes as low as possible, in order to have enough space for abnormal flow condition or SWTP/SETP shutdown. Within the SETP, underground water TDS (approximately 6% salinity) is adjusted at approximately 3% with surface contact water sourcing from the CP1 which has a salinity varying from (0.1-0.2 %). Water exiting the SETP is discharged to SP3 pond (volume max of 7867 m^3). Water is then pumped to a tanker truck, transported to Itivia discharge location (design report 6528-680-132-REP-001, AEM, 2019).

2.5 METHODOLOGY

The SETP design was based on hydrogeology and underground water quality data collected on a regular basis in the underground mine that is currently under production. Effluent quality of the SETP is set to comply with the regulation requirements.

The SETP should integrate the following component to successfully treat underground water and respect operational discharge water quality targets:

- Oil and grease removal unit;
- TSS removal unit;
- Ammonia chemical oxidation unit;
- Chlorine removal unit;
- TDS adjustment unit;
- Chemical make down and dosing skid.

2.6 WATER CHARACTERISTICS

The SETP is designed based on water quality of underground water inflows. Table 2 presents the water quality used for the design of the SWTP.

Table 2 : Feed Water Quality[1]

Date Sampled		2018-02-02	2018-03-16	2018-04-08	2018-05-06	2018-06-18	2018-07-12	2018-07-30	2018-08-13	2018-09-01	2018-09-17
Parameters	**Units**										
Bicarb. Alkalinity (calc. as CaCO3)	mg/L	96	94	80	88	100		57	61	83	69
Carb. Alkalinity (calc. as CaCO3)	mg/L	1.1	1.4	<1.0	<1.0	<1.0		<1.0	<1.0	<1.0	1.5
Total Ammonia-N	mg/L	330	260	250	280	250	230	190	200	160	120
Conductivity	µmhos/cm	98000	100000	95000	99000	81000	85000	84000	82000	87000	82000
Total Dissolved Solids (TDS)	mg/L	66400	65900	64800	62500	55800	61500	57400	60500	55800	52500
Fluoride (F-)	mg/L									-	<0.10
Total Kjeldahl Nitrogen (TKN)	mg/L	310	240	240	290	220	230	180	8.3	150	110
Dissolved Organic Carbon (DOC)	mg/L	15	15	14	14	9.3	10	21	11	9	7.1
Total Organic Carbon (TOC)	mg/L	16	23	17	15	10	12	22	<0.010	9.3	11
Orthophosphate (P)	mg/L	<0.010	0.022	<0.010	<0.010	0.016	<0.010	<0.010	7.61	<0.01	0.013
pH		8.08	8.19	7.97	7.2	7.24	7.19	7.77	0.38	7.22	8.36
Total Phosphorus (P)	mg/L	0.18	1.3	0.24	<0.20	0.18	0.17	0.22	590	0.18	0.11
Total Suspended Solids (TSS)	mg/L	460	1300	350	64	29	120	5	2800	210	730
Dissolved Sulfate (SO4)	mg/L	3 000	2600	2700	2300	2300	2800		0.1	3 000	3100
Total Cyanide (Cn)	mg/L	0.17	<0.25	0.14	0.15	0.11	0.15	0.12	240	0.066	0.07
Turbidity	NTU	240	1500	140	6	1.3	34	180	0.017	100	95

1 Used for Tender request.

Date Sampled		2018-02-02	2018-03-16	2018-04-08	2018-05-06	2018-06-18	2018-07-12	2018-07-30	2018-08-13	2018-09-01	2018-09-17
Parameters	**Units**										
Free Cyanide (Cn)	mg/L	0.057	0.064	0.03	0.037	0.043	0.025	0.016	180	0.027	0.015
Alkalinity (Total as CaCO3)	mg/L	97	96	80	88	100	87	57	61	83	71
Dissolved chloride (Cl)	mg/L	43000	46000	43000	40000	31000	38000		34000	35000	35000
Nitrite (as N)	mg/L	20.9	18.5	13	19.3	13.9	13.6	13.7	11.4	8.22	6.86
Nitrate (as N)	mg/L	410	358	295	330	280	254	258	245	225	179
Nitrite-Nitrate (as N)	mg/L	431	376	308	349	294	267	272	256	234	186
Radium-226	Bq/L	0.6	0.09	0.25	0.24	0.12	0.29	0.13	1.1	0.43	0.56
Total Oil & Grease	mg/L	8	6.6	1.7	1.5	1.1	<0.50	4.1	9.3	7.1	59
Mercury (Hg)	mg/L	<0.00001	<0.0001	<0.0001	<0.00001	<0.00001	<0.0002	<0.00001	<0.00001	0.00007	<0.00001
Dissolved Mercury (Hg)	mg/L	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Total Hardness (CaCO3)	mg/L	20400	19100	16700	68400	14300	13900	14300	13500	14700	13700
Total Aluminium (Al)	mg/L	14	36.6	8.37	3.57	0.43	4.02	9.44	13.9	7.32	2.27
Total Antimony (Sb)	mg/L	<0.025	<0.050	<0.025	0.019	<0.025	<0.025	<0.025	<0.025	<0.05	<0.025
Total Arsenic (As)	mg/L	0.109	0.072	0.0329	0.0228	0.0059	0.0353	0.0666	0.122	0.071	0.08
Total Barium (Ba)	mg/L	0.48	0.63	0.498	1.74	0.329	0.372	0.387	0.371	0.3	0.34
Total Beryllium (Be)	mg/L	<0.0050	<0.010	<0.0050	<0.0020	<0.0050	<0.0050	<0.0050	<0.005	<0.01	<0.005
Total Boron (B)	mg/L	<2.5	<5.0	<2.5	21.1	4	3.5	<2.5	2.9	<5.0	3.8
Total Cadmium (Cd)	mg/L	<0.00050	<0.0010	<0.00050	0.00415	0.00063	0.00133	<0.00050	<0.0005	<0.001	<0.0005
Total Chromium (Cr)	mg/L	0.083	0.16	<0.050	<0.020	<0.050	<0.050	0.067	0.059	<0.1	<0.05
Total Copper (Cu)	mg/L	0.053	0.069	<0.025	0.064	0.045	<0.025	<0.025	<0.034	<0.05	<0.025
Total Iron (Fe)	mg/L	30.2	53.6	16	6.02	<0.50	6.02	17.3	28.6	9.8	12.7
Total Lead (Pb)	mg/L	0.033	0.026	0.014	0.0064	<0.010	<0.010	0.011	0.025	<0.02	0.023
Total Lithium (Li)	mg/L	2.06	5.43	2.52	29.7	2.96	2.38	1.25	1.7	1.2	1.55
Total Manganese (Mn)	mg/L	1.09	0.96	0.482	2.54	0.59	0.668	0.508	1.02	0.61	0.787
Total Molybdenum (Mo)	mg/L	0.078	<0.10	0.101	0.265	0.061	0.074	0.085	0.058	<0.1	0.053
Total Nickel (Ni)	mg/L	0.067	0.1	<0.050	0.202	<0.050	0.056	<0.050	0.061	<0.1	<0.05
Total Selenium (Se)	mg/L	<0.0050	<0.010	<0.0050	0.0044	<0.0050	<0.0050	<0.0050	<0.05	<0.01	<0.005
Total Silver (Ag)	mg/L	0.001	<0.0020	<0.0010	0.00082	<0.0010	<0.0010	<0.0010	<0.001	<0.002	0.0016
Total Strontium (Sr)	mg/L	95.9	120	95.3	497	89.4	82.2	78.5	69.1	68	78.2
Total Thallium (Tl)	mg/L	0.00184	0.003	0.00197	0.0185	0.0016	0.00132	0.00074	0.00067	<0.001	0.00087
Total Tin (Sn)	mg/L	<0.25	<0.50	<0.25	<0.10	<0.25	<0.25	<0.25	<0.25	<0.5	<0.25
Total Titanium (Ti)	mg/L	<0.25	<0.50	<0.25	<0.10	<0.25	<0.25	<0.25	<0.25	<0.5	<0.25
Total Uranium	mg/L	<0.0050	<0.010	<0.0050	0.0277	0.0053	0.0065	<0.0050	<0.005	<0.01	<0.005
Total Vanadium	mg/L	<0.25	<0.50	<0.25	<0.10	<0.25	<0.25	<0.25	<0.25	<0.5	<0.25
Total Zinc	mg/L	<0.25	<0.50	<0.25	0.14	<0.25	<0.25	<0.25	<0.25	<0.5	<0.25
Total Calcium	mg/L	3770	4280	3390	14400	2710	2830	3040	2560	2390	2380
Total Magnesium	mg/L	2660	2040	2010	7890	1830	1650	1630	1720	2130	1840
Total Potassium	mg/L	785	723	681	2920	567	616	613	558	556	529

Date Sampled		2018-02-02	2018-03-16	2018-04-08	2018-05-06	2018-06-18	2018-07-12	2018-07-30	2018-08-13	2018-09-01	2018-09-17
Parameters	**Units**										
Total Sodium	mg/L	20900	17700	17400	59400	13800	12300	12900	13900	15700	13800
Dissolved Hardness	mg/L	18800	17800	17800	18500	14900	15100	15100	13700	15100	13600
Dissolved Aluminum (Al)	mg/L	<0.15	<0.30	<0.15	<0.15	<0.15	0.34	<0.30	0.28	<0.15	<0.15
Dissolved Antimony (Sb)	mg/L	<0.025	<0.050	<0.025	<0.025	<0.025	<0.025	<0.050	<0.025	<0.025	<0.025
Dissolved Arsenic (As)	mg/L	0.0161	0.016	0.0136	<0.0050	<0.0050	0.0248	0.034	0.0269	0.0575	0.0575
Dissolved Barium (Ba)	mg/L	0.44	0.54	0.486	0.466	0.351	0.364	0.35	0.326	0.328	0.328
Dissolved Beryllium (Be)	mg/L	<0.0050	<0.010	<0.0050	<0.0050	<0.0050	<0.0050	<0.010	<0.005	<0.005	<0.005
Dissolved Boron (B)	mg/L	3	<5.0	2.6	5.1	4.7	3.6	<5.0	2.8	<2.5	<2.5
Dissolved Cadmium (Cd)	mg/L	<0.00050	<0.0010	<0.00050	0.00089	0.00064	0.0011	<0.0010	<0.0005	<0.0005	<0.0005
Dissolved Chromium (Cr)	mg/L	<0.050	<0.10	<0.050	<0.050	<0.050	<0.050	<0.10	<0.05	<0.05	<0.05
Dissolved Copper (Cu)	mg/L	0.012	<0.020	<0.010	0.013	0.029	<0.010	<0.020	<0.01	<0.01	<0.01
Dissolved Iron (Fe)	mg/L	<0.25	<0.5	<0.25	<0.25	<0.25	<0.25	<0.50	<0.25	0.82	0.82
Dissolved Lead (Pb)	mg/L	<0.010	<0.020	<0.010	<0.010	<0.010	<0.010	<0.020	<0.01	<0.01	<0.01
Dissolved Lithium (Li)	mg/L	2.2	3.68	2.51	5.84	3.26	2.24	1.82 (1)	1.58	1.25	1.25
Dissolved Manganese (Mn)	mg/L	0.111	0.22	0.17	0.632	0.574	0.535	0.24	0.274	0.17	0.17
Dissolved Molybdenum (Mo)	mg/L	0.073	<0.10	0.111	0.072	0.062	0.076	<0.10	0.062	<0.05	<0.05
Dissolved Nickel (Ni)	mg/L	<0.050	<0.10	<0.050	0.051	<0.050	<0.050	<0.10	<0.05	<0.05	<0.05
Dissolved Selenium (Se)	mg/L	<0.0050	<0.010	<0.0050	<0.0050	<0.0050	<0.0050	<0.010	<0.005	<0.005	<0.005
Dissolved Silver (Ag)	mg/L	<0.0010	<0.0020	<0.0010	<0.0010	<0.0010	<0.0010	<0.0020	<0.001	<0.001	<0.001
Dissolved Strontium (Sr)	mg/L	91.5	115	100	136	106	100	81.9	71	60.9	60.9
Dissolved thallium (Tl)	mg/L	0.00194	0.0027	0.00155	0.0046	0.00157	0.00211	<0.0010	0.00069	<0.0005	<0.0005
Dissolved Tin (Sn)	mg/L	<0.25	<0.50	<0.25	<0.25	<0.25	<0.25	<0.50	<0.25	<0.25	<0.25
Dissolved Titanium (Ti)	mg/L	<0.25	<0.50	<0.25	<0.25	<0.25	<0.25	<0.50	<0.25	<0.25	<0.25
Dissolved Uranium	mg/L	<0.0050	<0.010	<0.0050	0.0066	0.0056	0.0062	<0.010	<0.005	<0.005	<0.005
Dissolved Vanadium	mg/L	<0.25	<0.50	<0.25	<0.25	<0.25	<0.25	<0.50	<0.25	<0.25	<0.25
Dissolved Zinc	mg/L	<0.25	<0.50	<0.25	<0.25	<0.25	<0.25	<0.50	<0.25	<0.25	<0.25
Dissolved Calcium	mg/L	3420	4050	3620	4150	2850	2870	2900	2580	2520	2520
Dissolved Magnesium	mg/L	2490	1860	2130	1980	1900	1930	1910	1750	1770	1770
Dissolved Potassium	mg/L	745	732	711	730	580	603	611	540	554	554
Dissolved Sodium	mg/L	19200	16700	17900	15100	14000	15000	14800	14400	14500	14500
Reactive Silica (Si)	mg/L	10	15	6.4	7.5	11	8.6	7.7	5.4	4.5	4.5

2.7 EFFLUENT FLOW RATE

In order to maintain the saline water balance, a treatment flow rate of 800 m^3/d is required which corresponds to the average inflow of saline water underground and partial saline water inventory decrease. 400 m^3/d of saline underground water will be treated through the units (Multilfo, Oils and grease separator, chlorination reactor).

3 DESCRIPTION

3.1 SALINE EFFLUENT TREATMENT PLANT (SETP)

The saline water feeding the SETP, will be pumped to the surface or from the saline pond's storage, to be treated first for oil and grease within the SETP. The oil and grease treated water will be transferred to a Multiflo® clarifier for TSS removal. The treated water overflows into a chlorination reactor where ammonia is oxidized into nitrogen gas by hypochlorite solution. The gasses generated by the water treatment unit will be discharges to the atmosphere. The excess of chlorine in water will be treated into a granular activated carbon filter prior to TDS adjustment at 3 % approximately. This TDS adjustment is performed with treated water effluent from CP1 and transferred to the holding pond or tank (SP3). From the pond, the water will be pumped into tanker trucks and transported to Itivia, to be placed in a local storage tank and disposed to the bay.

The treatment concept is presented in Figure 3. The P&ID can be found in Appendix A.

Due to the high corrosion potential of the water, materials are selected to minimize corrosion (stainless steel, plastic when possible). Units are also painted with specific corrosion resistant products.

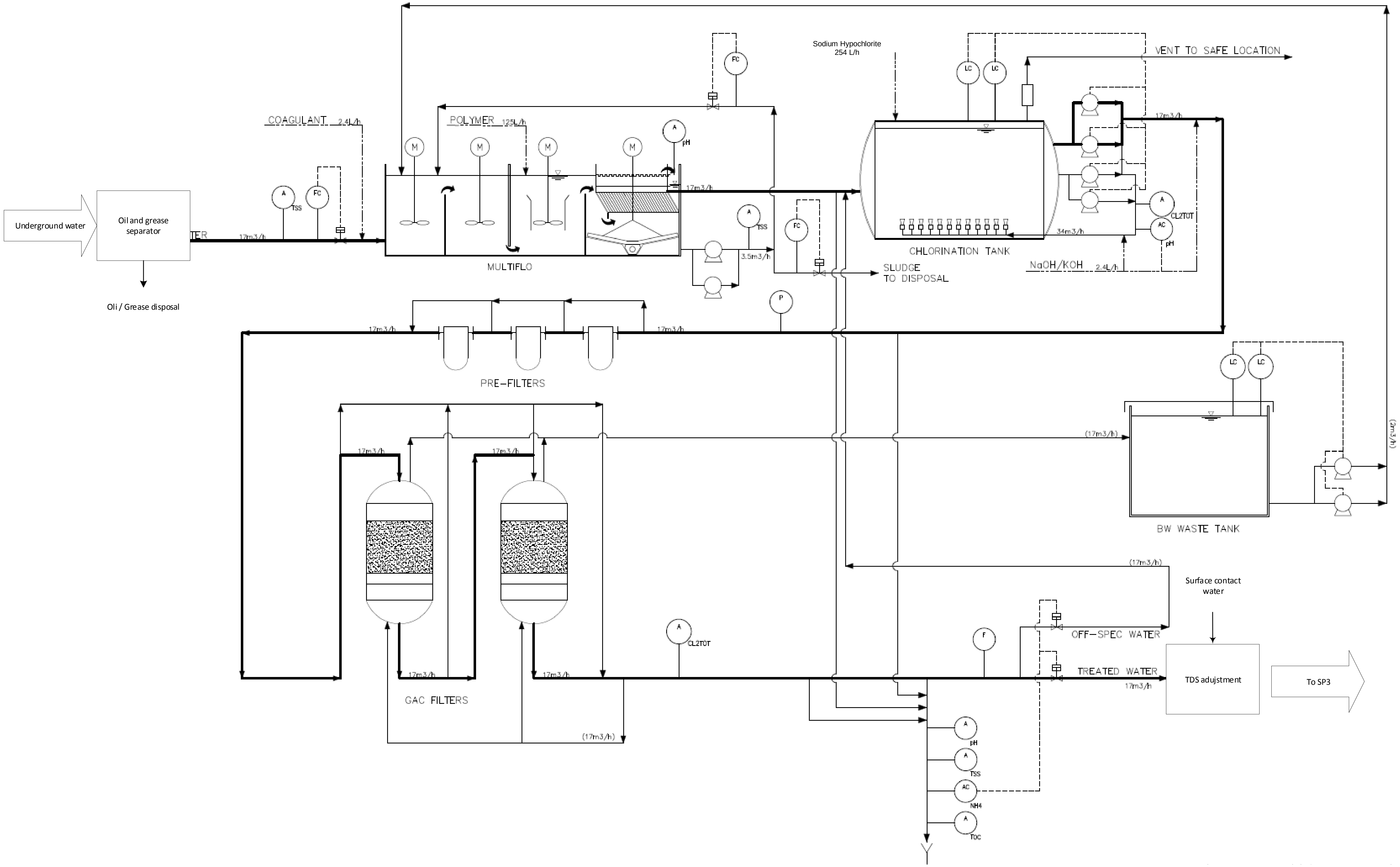

Figure 3 : SETP Overall Process Concept

3.2 OIL AND GREASE SEPARATOR

Before being fed to the Multiflo®, Oil and grease are removed.

Oil/Water Separators is designed to produce an effluent concentration of 5 mg/l or less of oil droplets 30 microns and larger of non-emulsified, free and dispersed oils (density 0.8-0.9). The coalescing media (1m^3, 160 m^2) and tank design, will also help to partially remove readily settleable solids. Periodic flushes of the tank are required and are sent to the Multiflo® by gravity. The unit is built in PoplyPropylene to resist corrosion.

The influent flow enters the clog proof influent diffuser and is immediately spread out across the depth and width of the chamber. Any readily settleable solids drop to the bottom of the V-shaped solid accumulation chamber located directly under the coalescing media pack.

The separation chamber is to be packed with cross-corrugated coalescing media (¾" plate spacing at 60° inclination). The media pack has been designed to create a quiescent zone, a laminar flow pattern to facilitate the impingement of oil on the media and will provide numerous impact sites and changes of flow direction.

An adjustable oil skimmer is provided for removing separated/floating oils from the separation chamber.

Figures 4 and 5 presents respectively the flowsheet of the unit and typical drawing.

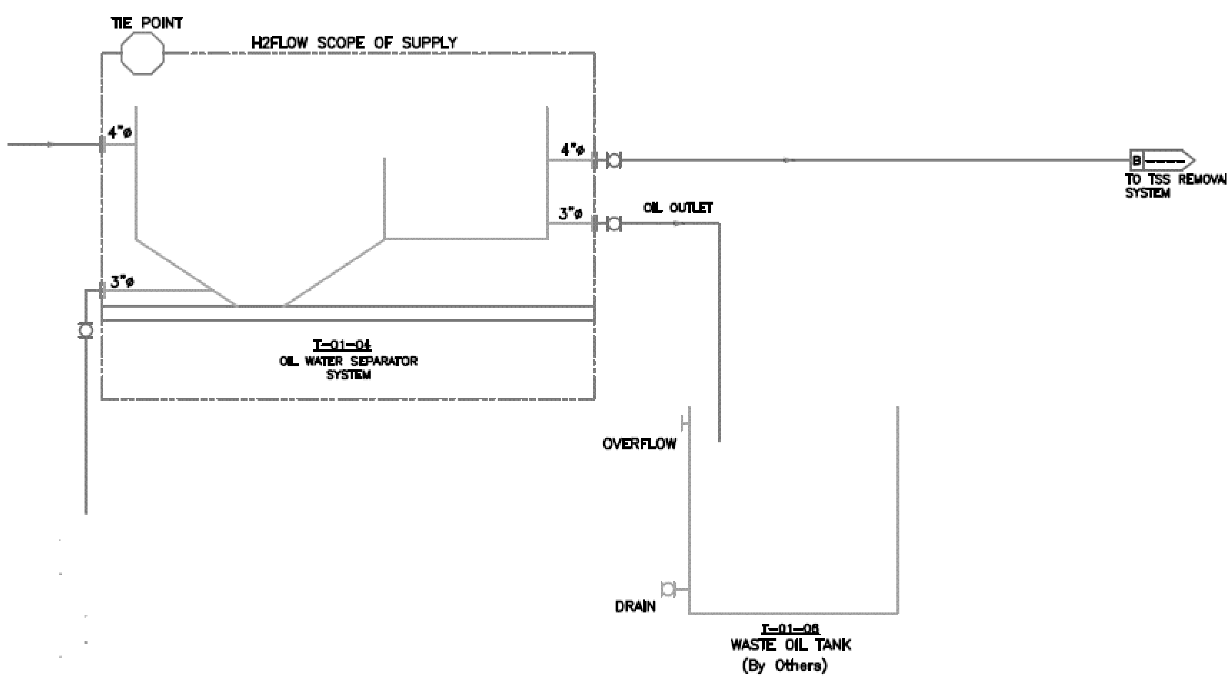

Figure 4 : Oil and Grease separator flowsheet

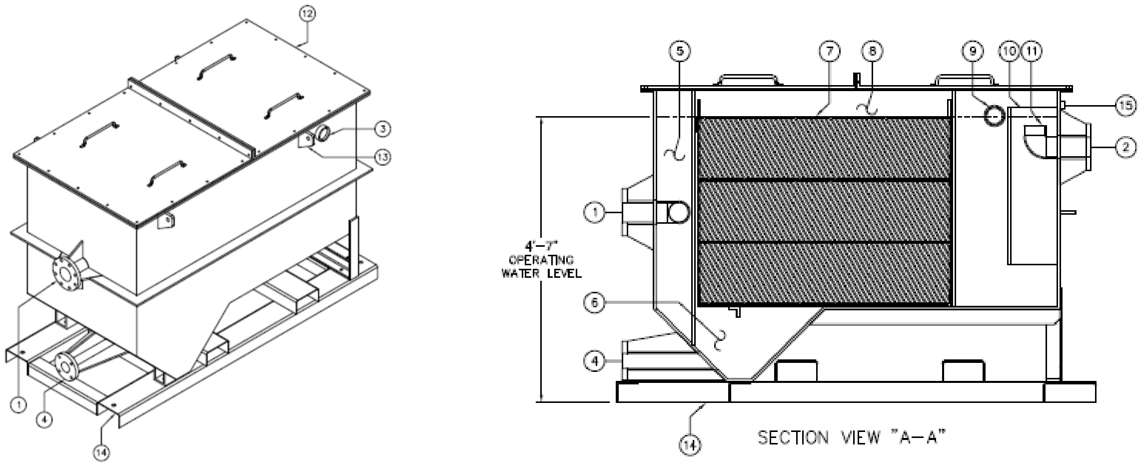

Figure 5 : Oil and Grease Drawing

3.3 MULTIFLO®

The raw water from the oil and grease removal will be pumped in a MULTIFLO® Clarifier. The proposed MULTIFLO® is designed to remove suspended solids presents in the water. The proposed MULTIFLO® has four chambers. The water flows to the first chamber, the coagulation chamber, where a coagulant is injected. The aluminum-based coagulant forms a floc of aluminum hydroxide ($Al(OH)_3$) which acts as a bridge to tie colloidal particles together. The water then flows into the second chamber, the injection tank, where an anionic polymeric flocculant is added to initiate floc formation. These serve as a “seed” for floc formation and development in the next process step. From the injection tank, the water underflows to a third tank section called the maturation tank. In this section, the sludge flocs agglomerate and grow into high-density. The water then flows to the settling tank, equipped with a lamella, which provides the rapid and effective removal of the sludge floc. The clarified water exits the system via a weir. The clarified water will have a monthly average concentration of TSS of less than 15 mg/L. The sludge settles to the bottom of the clarifier. Scrapers force the sludge collected at the bottom of the clarifier into a centre cone from which it is continuously withdrawn. The sludge will be extracted for disposal and will have a dry content of about 1 to 3 %.

The design settling velocity of the clarifier is set at 10 m/h for a feed flow rate of 400 m^3/d and the retention time within the flocculation section is 30 min.

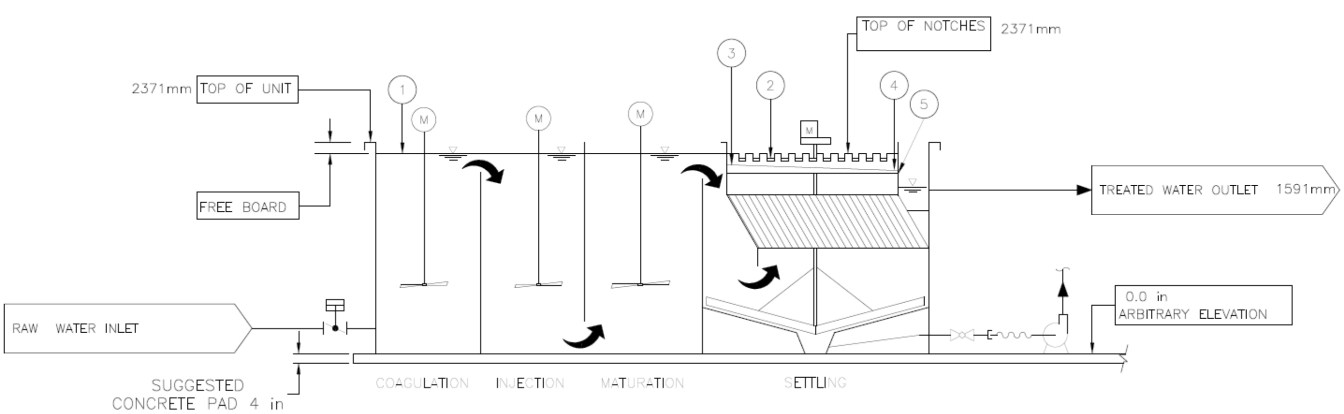

Figure 6 : Multiflo® typical drawing

3.4 BREAK POINT CHLORINATION

The raw water is then sent to a reaction tank where hypochlorite solution and an alkali (mix of NaOH/KOH) are added. The hypochlorite (OCl^-, chlorine) is a compound added to oxidize the ammonia ($NH4^+$) into nitrogen (N_2) nitrates (NO_3^-). The hypochlorite feed is added as a function of nitrites (NO_2^-) and ammonia concentration in the raw water.

The hypochlorite solution injected in the water produces hypochlorous acid (HOCl). The hypochlorous acid is a weak acid, and part of the hypochlorous acid is decomposed in water into hypochlorite ions (OCl^-) depending on the pH. The pH can be adjusted between 6 and 7 to optimize the chlorine dosage.

The hypochlorous acid and hypochlorite ions in solution will first be consumed by reducing agents and organic matter contained in the water. When more chlorine is added in solution and there is a presence of ammonia, the ammonia will react to form chloramines, specifically mono chloramines (NH_2Cl). When the quantity of chlorine is sufficient, the mono chloramines will be destroyed, and depending on the concentration, will be transformed in dichloramines ($NHCl_2$) or trichloramines (NCl_3) and then, finally, in nitrogen (N_2). If the quantity of chlorine injected is sufficient, a breakpoint is reached where all chloramines and ammonia are converted into nitrogen.

The overall reaction leading to the release of nitrogen and nitrate as a final product is presented below:

- $NH_4^+ + 1.5\ HOCl \rightarrow 0.5\ N_2 + 1.5\ H_2O + 2.5\ H^+ + 1.5\ Cl^-$
- $NH_4^+ + 4\ HOCl \rightarrow NO_3^- + H2O + 6\ H^+ + 4\ Cl^-$

Figure 7 also presents a graphical view of the break points determination.

The retention time within the chlorination tank is typically around 10 to 20 minutes.

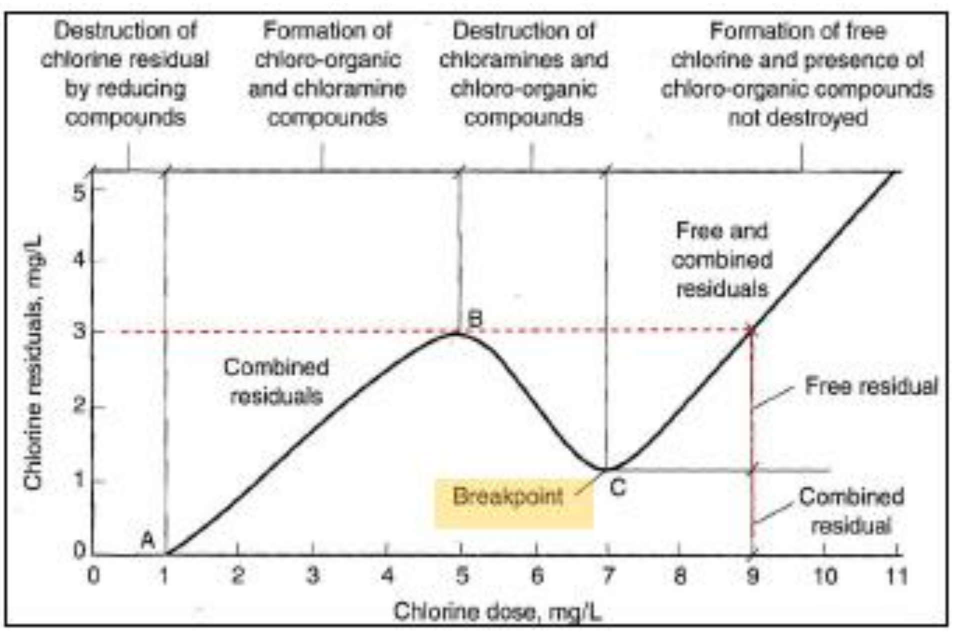

Figure 7 : Break point determination

The chlorination tank is agitated by recirculating water through eductors within the tank.

3.5 CARTRIDGE FILTRATION

Before being fed to the GAC filter, water is filtered through three cartridge filters with hole size of 50, 25 and 5 μm. This step limits the clogging risk within the GAC filter. One to two filters are expected to be used per week.

3.6 GRANULAR ACTIVATED CARBON (GAC) FILTER

The water will then be pumped to Pressure Filters filled with Granulated Activated Carbon (GAC).The water is forced to pass through the filters, as a result of the pressure from the pump, and be exposed to the GAC for a period of time. The residual chlorine and any chlorine by products will be removed with the GAC filters. The treated water is then monitored for total chlorine, ammonia, pH, and turbidity. The GAC Filter backwash will allow cleaning TSS formed within the filter and is expected less than 1 backwash per day. The backwash duration is expected to be 20 minutes or less. Backwash water will be sent back to the Multiflo® feed.

As a guideline only, supplier estimates that the carbon will have a lifetime of 190 days or more, assuming chlorine residual of 5 mg/L and a concentration of TOC of 3 mg/L. The chlorine residual depends on operations, variation of quality and flow of the raw water and temperature.

The filtration and back flush rate are set at 8.3 m/h (filtration surface of approx. 2m^2). The backwashes will be at countercurrent that the filtration. Two-pressure filter will be in series to ensure a contact time of 20 minutes.

The activated carbon used is 12x40 SAW (Acid washed, Continental Carbon) and have a capacity of chlorine removal higher than required for summer operation of the SETP. The specs of the GAC are presented below:

- Size: 12x40 mesh
- Surface Area: 1100 m^2/g
- Hardness: 97%
- Density: 0.48-0.53 g/cc
- pH: 6-8

3.7 SALINE MIXING TANK

Water being discharged to the sea must comply with a TDS concentration of approx. 3.6 % (+/- 10%, see 6528-680-132-REP-001). Treated saline water TDS will be adjusted with treated contact surface water (TDS 0.1-0.2 %) sourcing from CP1 within a tank controlled by conductivity meter. Water used for TDS adjustment will be treated prior using in the SETP by TSS removal unit (Actiflo system on site).

3.8 REAGENTS

The following reagents will be used at the SETP:

- Coagulant: Hydrex 6240 (Veolia) or equivalent
- Anionic polymer: Hydrex 6105 (Veolia) or equivalent
- Caustic blend: Hydrex 9501 (Veolia) or equivalent

- Sodium hypochlorite: (Veolia) or equivalent

The expected dosages are presented in table 3.

Table 3 : Expected Chemical Dosage (normal operation)

Chemical	Unit	Dosage
Coagulant	kg/m^3 of neat liquid as received	0.1
Anionic polymer	Kg/m^3 dry basis	0.01
Caustic blend	kg/m^3 of neat liquid as received	0.106
Sodium hypochlorite	kg/m^3 of neat liquid as received	12.5 (depend on ammonia feed concentration)

Most of the chemicals are supplied in liquid form (and dosed using a dosing skid pump directly into the process) except for the polymer which must be prepared with a dedicated make down unit before dosing. The solutions made with these products are prepared according to the MSDS provided by the suppliers. The application for each of these reagents is detailed in the Operation and Maintenance Manual (OMM).

Coagulant Injection: Aluminum Chloride

The selected coagulant is Hydrex 6240, an aluminum chloride coagulant. It will be received in bulk containers of 1 m^3 at 9.0% concentration as aluminum. The dosage will be performed using a mechanical diaphragm metering pump.

Polymer makedown and injection: Anionic Polymer

The use of a flocculation agent is essential for a TSS removal process in cold temperature. The polymer is typically selected during laboratory tests but the Hydrex 6105 has shown good results on similar water. Hydrex 6105 is a solid, anionic polymer used to enhance flocculation and will be received in 25 kg bags. One automatic preparation makes down the system will be used to prepare a 0.2 % solution. Warm water is used for the polymer preparation. The solution will be dosed using a mechanical metering pump specifically designed for high viscosity products.

NaOH/KOH injection: Hydrex 9501

Hydrex 9501 will be received in bulk containers of 1 m^3 at 47% concentration. Hydrex 9501 (NaOH/KOH blend**)** will be used since sodium hydroxide has a freezing point of 12 °C and needs to be stored in warm conditions to avoid freezing; Hydrex 9501 has a freezing point at -25°C. It is a hazardous product (class 8-corrosive) and needs to be handled accordingly. The dosage will be performed using a mechanical diaphragm metering pump specifically designed.

Sodium hypochlorite injection: Hydrex 9560

Sodium hypochlorite (Hydrex 9560) is used to oxidize ammonia. It will be received by tote at a concentration of 12%. It will be transferred to the process by a peristaltic metering pump. To avoid degradation of hypochlorite solution, tote tank must be stored in sea can in dark and temperate environment.

3.9 SERVICE WATER SYSTEM

The service water system is mainly based on reusing distilled water produced within the SWTP. A 21 m^3 clean water reserve tank is being used for storage within the SWTP building. This water will be reused for polymer solution preparation.

For polymer make down, the requirements are the following:

- Flow rate: 5.2 m^3/h (used by batches)
- Pressure > 65 PSIG
- Temperature > 10 °C
- Conductivity < 10,000 μS/cm
- Chlorine < 0.5 mg Cl_2/L
- TSS: filtrated on a 100 μm filter

Since treated water from SWTP is a distilled and osmosed water, the requirements are met.

3.10 WATER HEATER

No water heater is required. SWTP post-treated water will be used for polymer preparation and is already warm (approx. 30°C).

3.11 SOLID WASTE MANAGEMENT

Sludge from Multiflo®

Sludge produced in the Multiflo® system will be sent back underground by an old temporary line feeding the SWTP. The line will send sludge underground where it will be managed with underground mine water. Underground sludge is managed through the sump, clarification system and stope. The sludge production is estimated between 3 and 10 m^3/d at a solid content varying between 1 and 3%.

GAC

Spent GAC will be stored in the Tailing storage facility or waste rock storage facility or sent in an appropriate landfill.

3.12 HAZARDOUS WASTE MANAGEMENT

Oils and grease generated within the SETP will be stored into a dedicated tank. When full, the tank will be managed accordingly with the regulation (send to an accredited contactor for disposal/processing).

3.13 CONTROLS

The general control strategy is detailed in the Appendix B. The SETP pump and dosing skid will be controlled by a series of sensor measuring level, flow and water quality.

Table 4 presents a summary of on-line analysis performed for water quality control.

Table 4 : On Line Water Quality Monitoring

Parameters	Raw water	Multiflo®	Chlorination tank	GAC filter	Treated water
pH		X	X	X	X
Conductivity					X
Temperature		X	X	X	X
Ammonia		X	X	X	
Turbidity		X			X
TSS	X	X		X	
TOC		X	X	X	
Free chlorine			X		
Total chlorine			X	X	

4 CONSTRUCTION METHODS AND COMMISSIONING

4.1 PIPING AND PUMPING

For the operation of the SETP, pumping and piping are required to convey water:

- Inside the building of the SETP;
- From the raw water tank of the SWTP to the SETP;
- From the treated water tank of the SWTP to the SETP;
- Treated water from the existing 16 in pipe coming from the EWTP to the SETP;
- Treated water from the SETP to SP3;
- Treated water from the SP3 to the truck pumping station;
- Raw water from SP1 to SP2;
- from the Multiflo® to the underground mine for sludge discharge.

Pipe will be above-ground and will lie directly on the tundra. The sharp stones will be removed before the pipe installation to reduce the risks of tears and premature wear.

4.2 CONSTRUCTION METHOD AND EQUIPMENT

4.2.1 FOUNDATION PREPARATION

All aspects of the civil earthwork's construction, including foundation preparation and backfill procedures will be according to the Technical Specifications for Civil Earthworks (Tetra Tech, 2017) unless otherwise stated below.

R.O.M. material will be used to level the existing pad behind the SWTP building and 0-50 mm will be placed to cover the surface and to allow the erection of the building and a safe walking surface.

Since the pad has been already constructed previously, no additional effect on tundra is expected. Runoff water resulting from the SETP construction will be captured within the containment pond CP5 watershed.

4.2.2 SALINE EFFLUENT TREATMENT PLANT BUILDING

A building will be erected on the pad previously built on the west side of the SWTP. The building will be done with 3 rows of 20 ft long containers sitting one on top of the other on 3 sides. The containers will be put in place with a hyster. A welder in an aerial working platform will weld them in place. A structural steel frame with insulated panels, an overhead door and a man's door will be completing the perimeter of the building. An existing engineered wooden roof installed with the hyster will cover the infrastructure.

All equipment in the building will be sitting either, on steel frames, in a container or on the ground. Power will be sourced from the existing installation at portal 1 and distributed inside the building. A liner will be installed inside the building to cover and protect the ground in case of spill.

4.2 QUALITY CONTROL/ASSURANCE

A quality control/assurance program will be required during construction of each of the infrastructure components to ensure that construction-sensitive features of the design are achieved.

A quality control report, including details of all QC test results and a record of as-built drawings will be produced.

4.3 TESTING AND INSPECTION

Prior to start up, the indoor/outdoor pipe will be tested for leaks. If leaks are found, the joint will be re-welded or re-torqued.

After start-up, a periodic inspection, performed by Agnico Eagle personal, will be done to ensure piping integrity.

4.4 TIMELINE

The expected date of the operation is planned to be the beginning of July 2019.

Appendix A: SETP Drawings

Drawing #	Rev.	Area	Discipline	Description #1	Description #2
65-680-205-001	1	680 - SALINE EFFLUENT TREATMENT PLANT	205 - PIPING & INSTRUMENTATION DIAGRAM	MULTIFLO CLARIFIER	
65-680-205-002	0	680 - SALINE EFFLUENT TREATMENT PLANT	205 - PIPING & INSTRUMENTATION DIAGRAM	MULTIFLO CLARIFIER & CHLORINATION TANK	
65-680-205-003	0	680 - SALINE EFFLUENT TREATMENT PLANT	205 - PIPING & INSTRUMENTATION DIAGRAM	MULTIFLO CLARIFIER & CHLORINATION TANK FILTERS	
65-680-205-004	0	680 - SALINE EFFLUENT TREATMENT PLANT	205 - PIPING & INSTRUMENTATION DIAGRAM	MULTIFLO CLARIFIER & CHLORINATION TANK	COAGULANT & POLYMER
65-680-205-005	1	680 - SALINE EFFLUENT TREATMENT PLANT	205 - PIPING & INSTRUMENTATION DIAGRAM	MULTIFLO CLARIFIER & CHLORINATION TANK	NaOH/KOH & NaOCl
65-680-205-006	0	680 - SALINE EFFLUENT TREATMENT PLANT	205 - PIPING & INSTRUMENTATION DIAGRAM	SP3 POND	
65-680-210-200	0	680 - SALINE EFFLUENT TREATMENT PLANT	210 - GENERAL ARRANGEMENT	EQUIPMENT PLANNING	PLAN VIEW
65-680-245-200	1	680 - SALINE EFFLUENT TREATMENT PLANT	245 - STRUCTURAL STEEL	EQUIPMENT SUPPORT	PLAN VIEW
65-680-245-201	0	680 - SALINE EFFLUENT TREATMENT PLANT	245 - STRUCTURAL STEEL	EQUIPMENT SUPPORT	PLAN VIEW
65-680-275-200	0	680 - SALINE EFFLUENT TREATMENT PLANT	275 - POWER ELECTRICAL	GROUNDING	PLAN VIEW
65-680-275-201	0	680 - SALINE EFFLUENT TREATMENT PLANT	275 - POWER ELECTRICAL	600V - DISTRIBUTION PANEL	65DPP68001
65-680-275-202	0	680 - SALINE EFFLUENT TREATMENT PLANT	275 - POWER ELECTRICAL	MOTOR & EQUIPMENT LOCATION	PLAN VIEW
65-680-275-203	0	680 - SALINE EFFLUENT TREATMENT PLANT	275 - POWER ELECTRICAL	CABLE TRAY	PLAN VIEW
65-680-285-200	0	680 - SALINE EFFLUENT TREATMENT PLANT	275 - POWER ELECTRICAL	LIGHTING & SERVICES	PLAN VIEW

NO. DESSIN DRAWING NO. 65-680-205-001_R1

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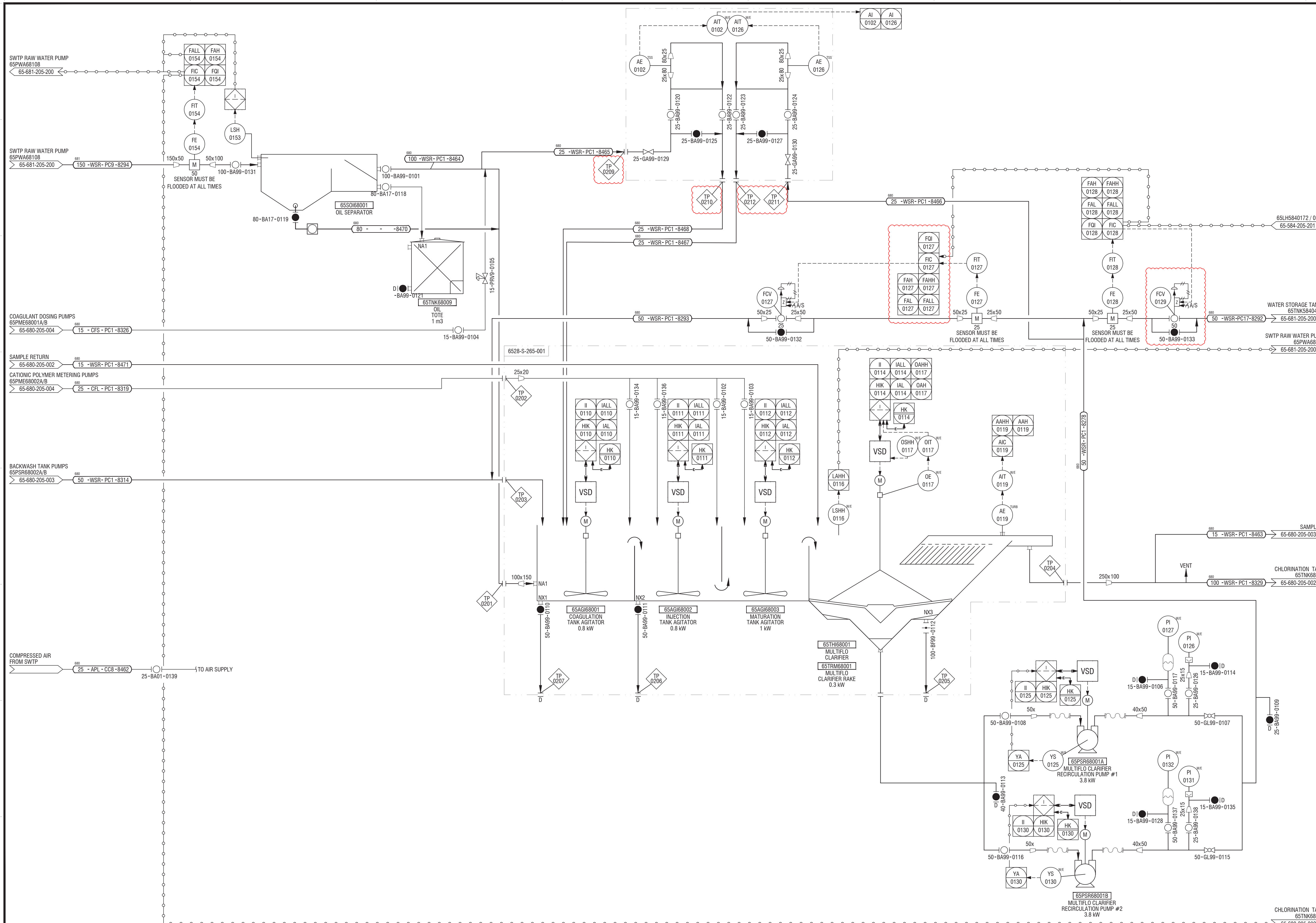

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PLAN CLÉ KEY PLAN

NOTES GÉNÉRALES / GENERAL NOTES

POUR CONSTRUCTION FOR CONSTRUCTION DATE: 2019-04-24

DESSINS EN RÉFÉRENCE / REFERENCE DRAWINGS

TITRE / TITLE	# DWG

AGNICO EAGLE

REV.	DATE	DESCRIPTION	PAR/BY	APP.	CLIENT
1	2019-04-24	ADDED MODULATING VALVE	S.P.	E.L.	
0	2019-04-11	ISSUED FOR CONSTRUCTION	S.P.	E.L.	
A	2019-03-21	PRELIMINARY	J.L.	S.P.	

REVISIONS

REGISTERED PROFESSIONAL ENGINEER L2897 E. LAVOIE LICENSEE NT/NU 24-04-2019

TITRE / TITLE
AGNICO EAGLE – MELIADINE DIVISION
680 – SALINE EFFLUENT TREATMENT PLANT
205 – PIPING & INSTRUMENTATION DIAGRAM
MULTIFLO CLARIFIER

DESSINÉ PAR DRAWN BY	JONATHAN LAVOIE	DATE 2019-03-21
VERIFIÉ PAR CHECKED BY	SÉBASTIEN PERRON	2019-03-21
APPROUVÉ PAR APPROVED BY	ÉRIC LAVOIE, P. Eng.	2019-04-24
ÉCHELLE SCALE	NO SCALE	DATE 2019-01-17

NO. DESSIN DRAWING NO. 65-680-205-001

NO. PROJET PROJECT NO.	REVISION	FEUILLE / SHT
6528	1	1 / 1

FILE NO. 65-680-205-001_R1.dwg

NO. DESSIN / DRAWING NO. 65–680–205–002_R0

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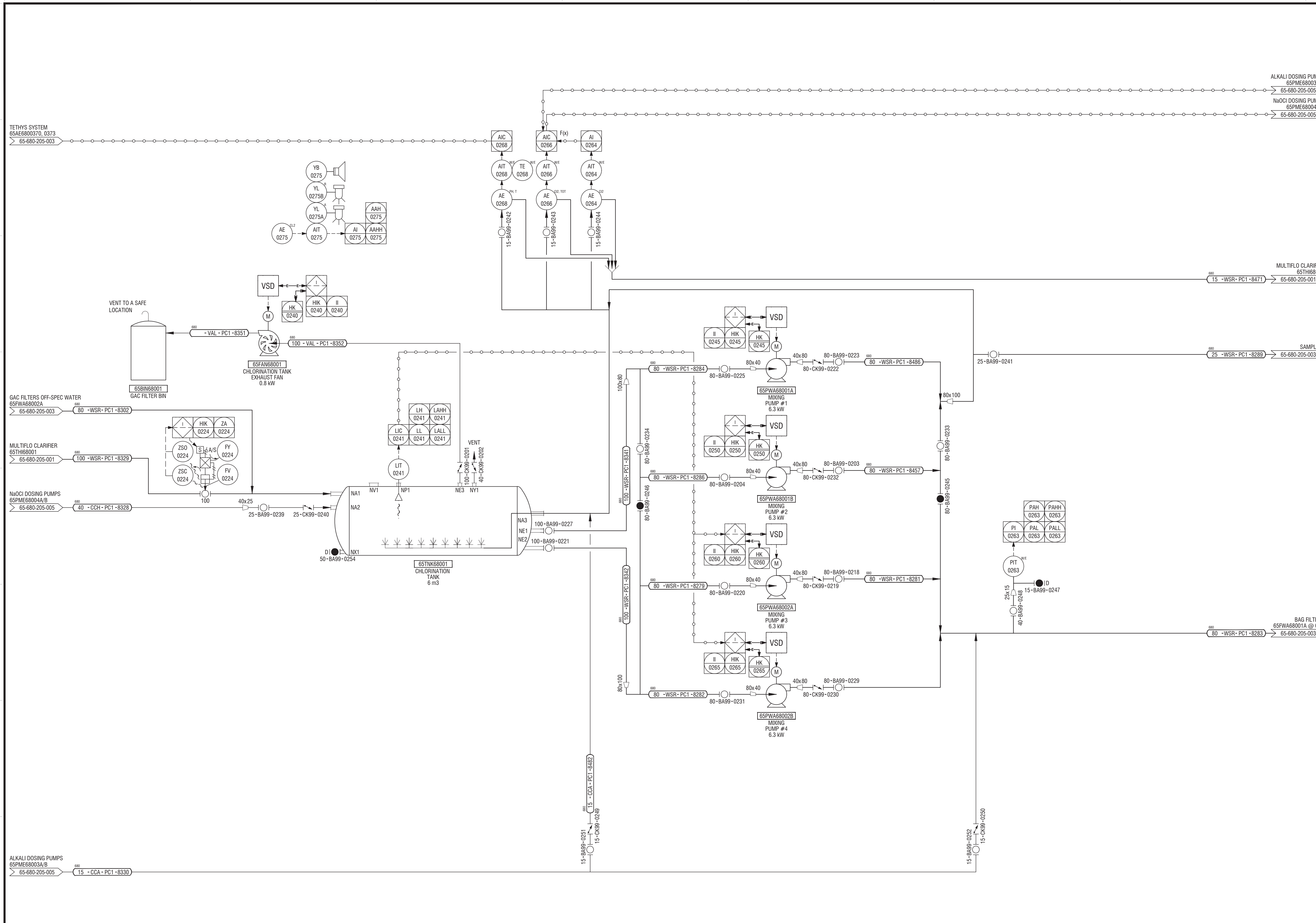

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FOR CONSTRUCTION
DATE : 2019–04–11

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0	2019–04–11	ISSUED FOR CONSTRUCTION	S.P.	E.L.	
A	2019–03–21	PRELIMINARY	J.L.	S.P.	

REVISIONS

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TITRE / TITLE
AGNICO EAGLE – MELIADINE DIVISION
680 – SALINE EFFLUENT TREATMENT PLANT
205 – PIPING & INSTRUMENTATION DIAGRAM
MULTIFLO CLARIFIER & CHLORINATION TANK

DESSINÉ PAR / DRAWN BY	JONATHAN LAVOIE	DATE 2019–03–21
VERIFIÉ PAR / CHECKED BY	SÉBASTIEN PERRON	2019–03–21
APPROUVÉ PAR / APPROVED BY	ÉRIC LAVOIE, P. Eng.	2019–04–11
ÉCHELLE / SCALE	NO SCALE	DATE 2019–01–17

NO. DESSIN / DRAWING NO. 65–680–205–002

NO. PROJET / PROJECT NO.	REVISION	FEUILLE / SHT
6528	0	1 / 1

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FILE NO. 65–680–205–002_R0.dwg

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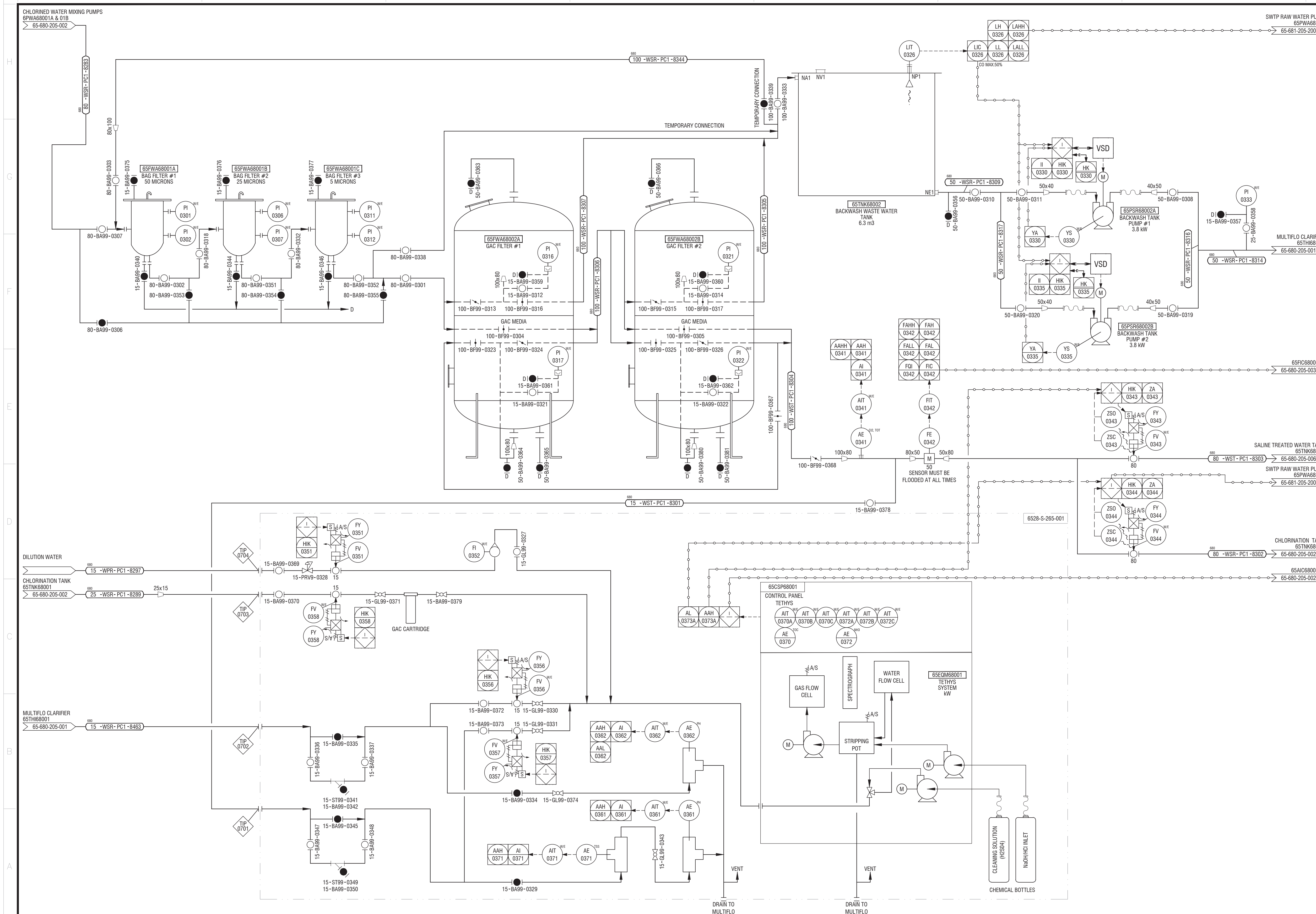

PLAN CLÉ / KEY PLAN

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A	2019-03-21	PRELIMINARY	J.L.	S.P.	

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TITRE / TITLE
AGNICO EAGLE – MELIADINE DIVISION
680 – SALINE EFFLUENT TREATMENT PLANT
205 – PIPING & INSTRUMENTATION DIAGRAM
MULTIFLO CLARIFIER & CHLORINATION TANK FILTERS

DESSINÉ PAR / DRAWN BY	JONATHAN LAVOIE	DATE	2019-03-21
VÉRIFIÉ PAR / CHECKED BY	SÉBASTIEN PERRON		2019-03-21
APPROUVÉ PAR / APPROVED BY	ÉRIC LAVOIE, P. Eng.		2019-04-11
ÉCHELLE / SCALE	NO SCALE	DATE	2019-01-17

NO. DESSIN / DRAWING NO. 65-680-205-003

NO. PROJET / PROJECT NO.	REVISION	FEUILLE / SHT
6528	0	1 / 1

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FILE NO. 65-680-205-003_R0.dwg

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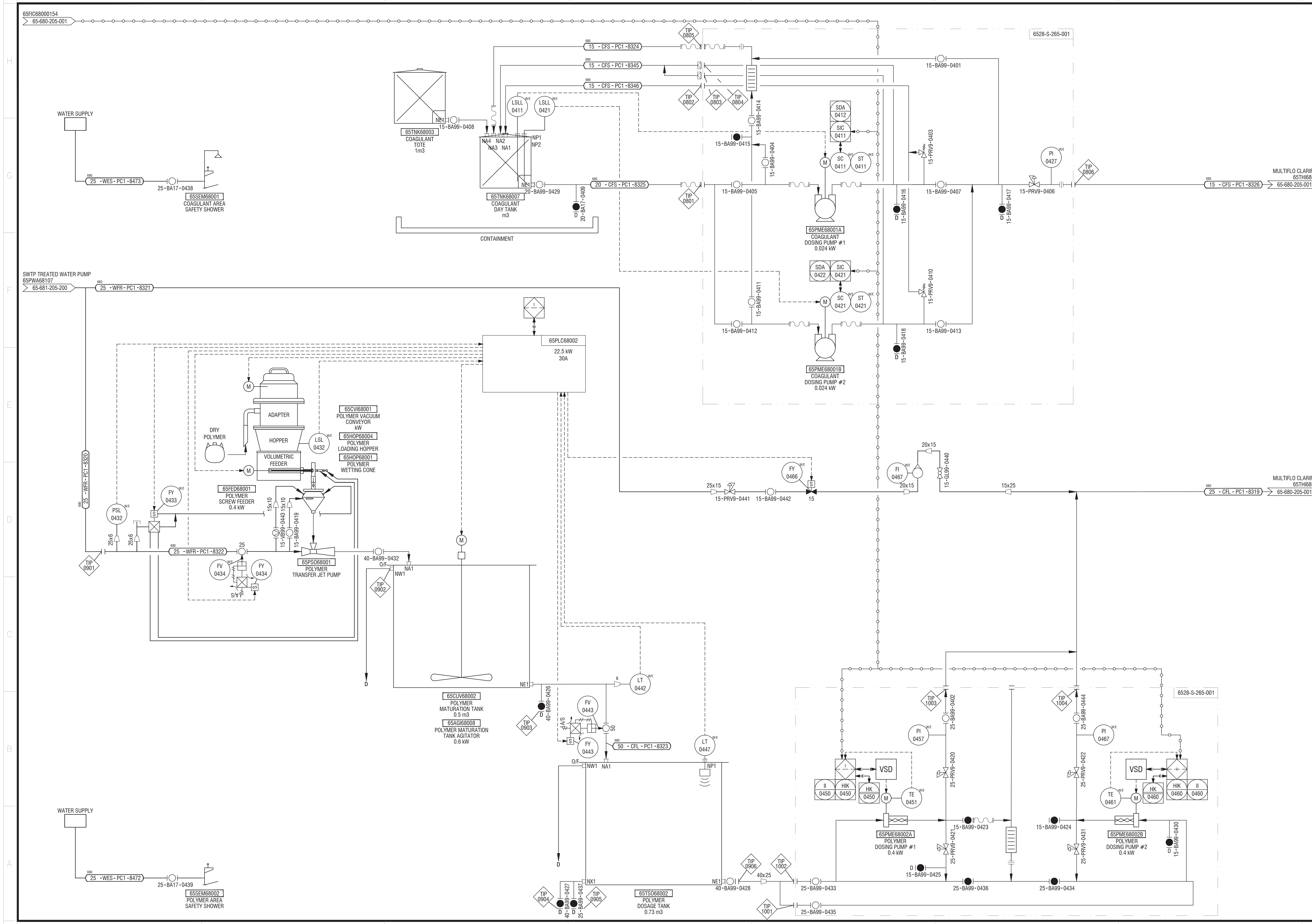

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A	2019-03-21	PRELIMINARY	J.L.	S.P.	

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11-04-2019

TITRE / TITLE
AGNICO EAGLE – MELIADINE DIVISION
680 – SALINE EFFLUENT TREATMENT PLANT
205 – PIPING & INSTRUMENTATION DIAGRAM
MULTIFLO CLARIFIER & CHLORINATION TANK
COAGULANT & POLYMER

DESSINÉ PAR / DRAWN BY	JONATHAN LAVOIE	DATE 2019-03-21
VERIFIÉ PAR / CHECKED BY	SÉBASTIEN PERRON	2019-03-21
APPROUVÉ PAR / APPROVED BY	ÉRIC LAVOIE, P. Eng.	2019-04-11
ÉCHELLE / SCALE	NO SCALE	DATE 2019-01-17

NO. DESSIN / DRAWING NO. 65-680-205-004

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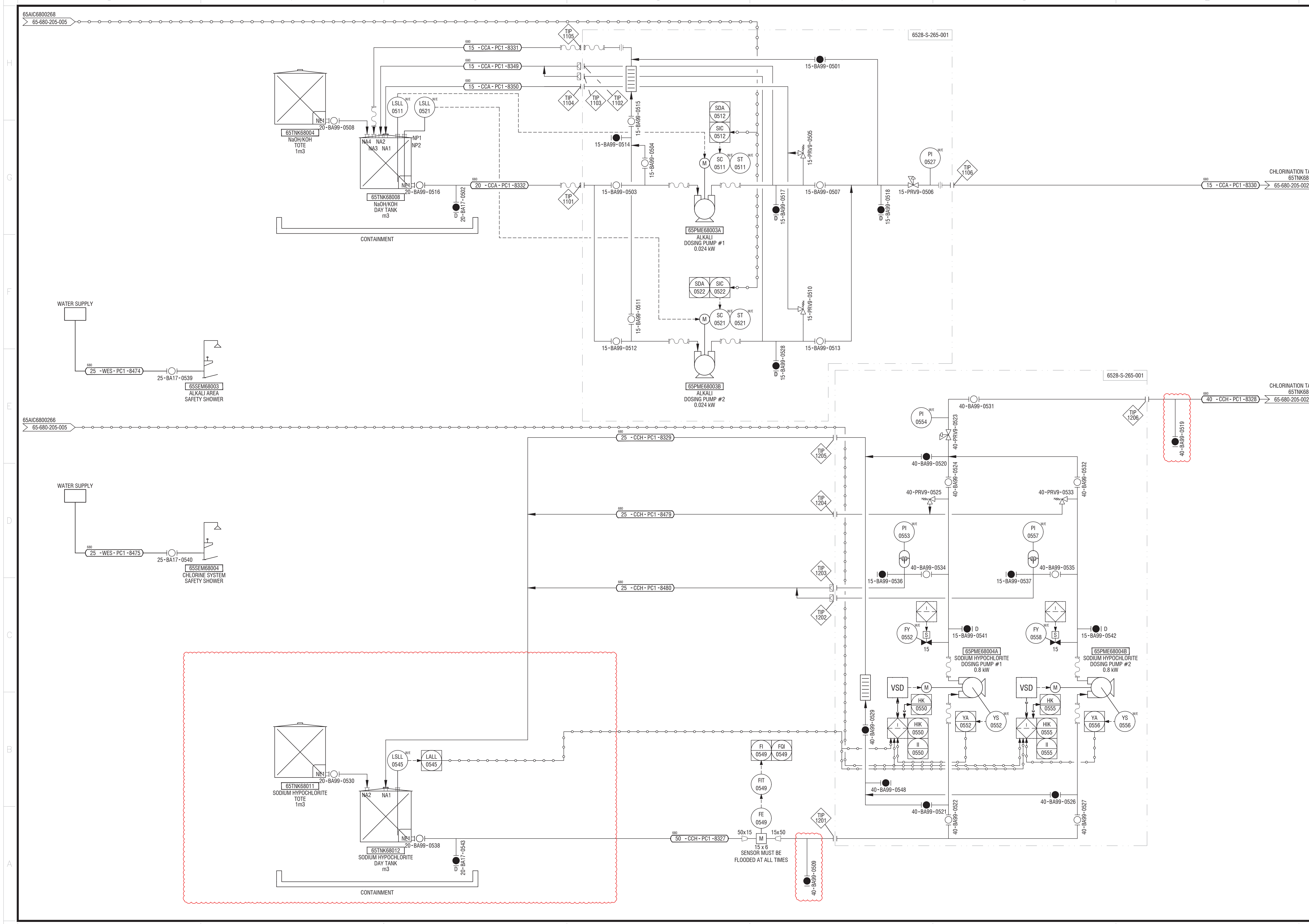

PLAN CLÉ
KEY PLAN

NOTES GÉNÉRALES / GENERAL NOTES

POUR CONSTRUCTION
FOR CONSTRUCTION
DATE : 2019-04-24

DESSINS EN RÉFÉRENCE / REFERENCE DRAWINGS

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REV.	DATE	DESCRIPTION	PAR/BY	APP.	CLIENT
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0	2019-04-11	ISSUED FOR CONSTRUCTION	S.P.	E.L.	
A	2019-03-21	PRELIMINARY	J.L.	S.P.	

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24-04-2019

TITRE / TITLE
AGNICO EAGLE – MELIADINE DIVISION
680 – SALINE EFFLUENT TREATMENT PLANT
205 – PIPING & INSTRUMENTATION DIAGRAM
MULTIFLO CLARIFIER & CHLORINATION TANK
NaOH/KOH & NaOCl

DESSINÉ PAR / DRAWN BY	JONATHAN LAVOIE	DATE 2019-03-21
VERIFIÉ PAR / CHECKED BY	SÉBASTIEN PERRON	2019-03-21
APPROUVÉ PAR / APPROVED BY	ÉRIC LAVOIE, P. Eng.	2019-04-24
ÉCHELLE / SCALE	NO SCALE	DATE 2019-01-29

NO. DESSIN / DRAWING NO. 65-680-205-005

NO. PROJET / PROJECT NO.	REVISION	FEUILLE / SHT
6528	1	1 / 1

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FILE NO. 65-680-205-005_R1.dwg

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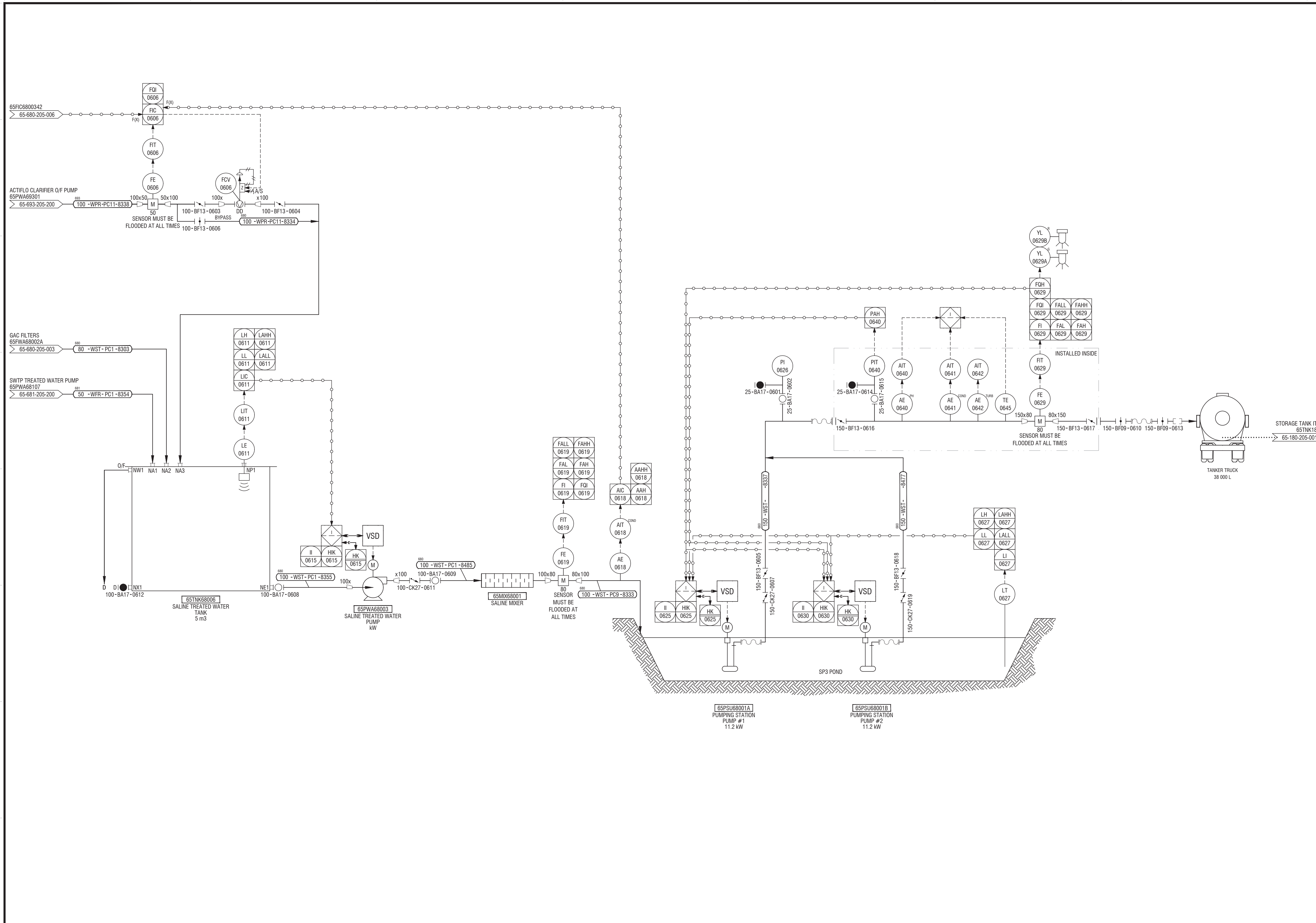

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FOR CONSTRUCTION
DATE : 2019-04-11

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AGNICO EAGLE – MELIADINE DIVISION
680 – SALINE EFFLUENT TREATMENT PLANT
205 – PIPING & INSTRUMENTATION DIAGRAM
SP3 POND

DESSINÉ PAR / DRAWN BY	JONATHAN LAVOIE	DATE 2019-03-21
VERIFIÉ PAR / CHECKED BY	SÉBASTIEN PERRON	2019-03-21
APPROUVÉ PAR / APPROVED BY	ÉRIC LAVOIE, P. Eng.	2019-04-11
ÉCHELLE / SCALE	NO SCALE	DATE 2019-01-17

NO. DESSIN / DRAWING NO. 65-680-205-006

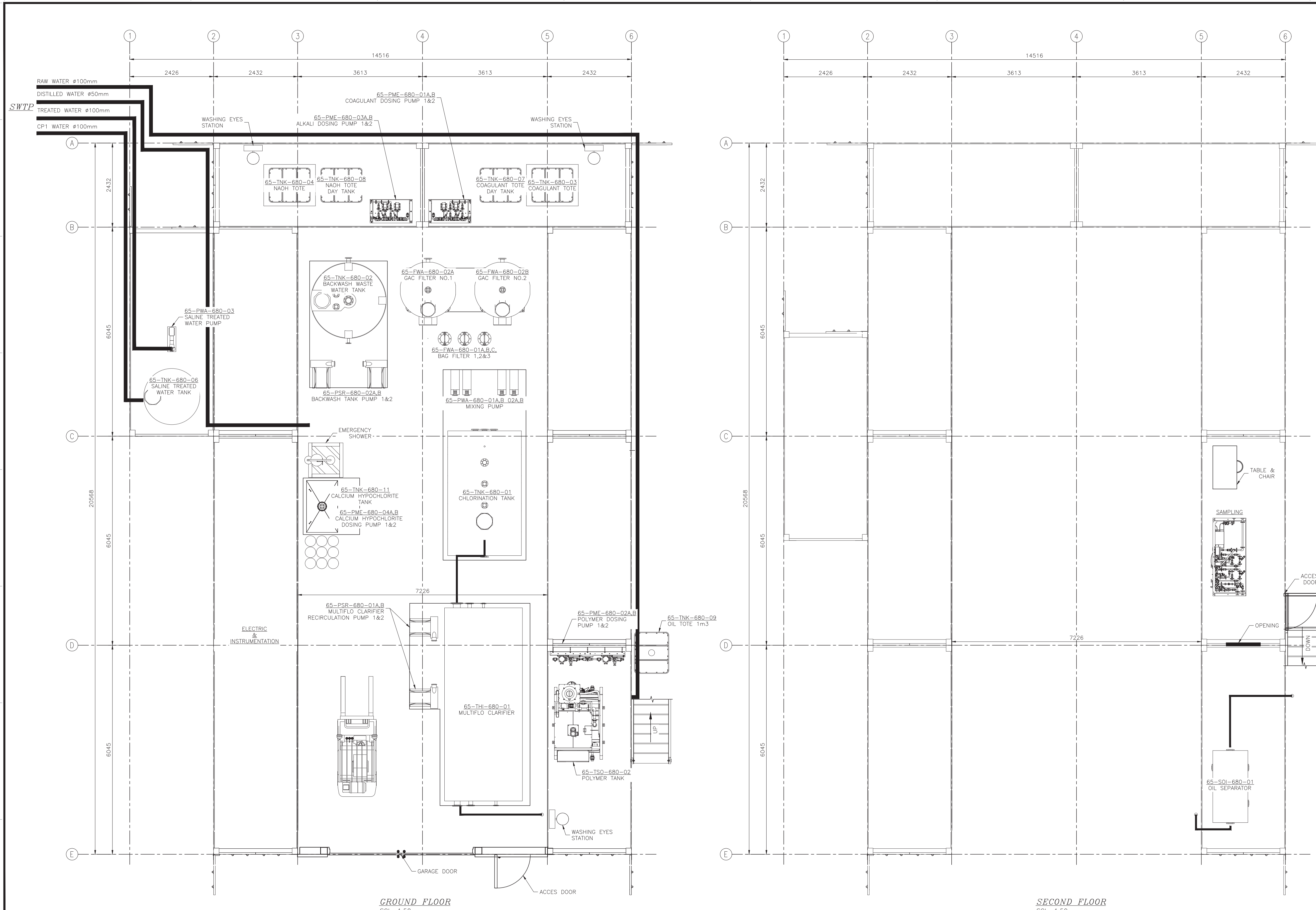
NO. PROJET / PROJECT NO.	REVISION	FEUILLE / SHT
6528	0	1 / 1

AE-CART-ARCH D

FILE NO. 65-680-205-006_R0.dwg

NO. DESSIN DRAWING NO. 65-680-210-200_R0

FORMAT ARCHD



PLAN CLÉ
KEY PLAN

1075, 3e AVENUE EST
VAL-D'OR (QUÉBEC) CANADA J9P 0J7
TÉL. : 819 825-4274 | TÉLÉC. : 819 824-1514 | WWW.WSPGROUP.COM

Ref. 181-15686-00

NOTES GÉNÉRALES / GENERAL NOTES

POUR SOUMISSION
FOR TENDER
AGNICO EAGLE
DATE : 21-03-19

DESSINS EN RÉFÉRENCE / REFERENCE DRAWINGS

TITRE / TITLE	# DWG
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AGNICO EAGLE

REV.	DATE	DESCRIPTION	PAR/BY	APP.	CLIENT
0	2019-03-21	ISSUED FOR TENDER	C.G.	D.R.	

REVISIONS

TITRE / TITLE
AGNICO EAGLE – MELIADINE DIVISION
680 – SALINE EFFLUENT TREATMENT PLANT
210 – GENERAL ARRANGEMENT
EQUIPEMENT PLANNING
PLAN VIEW

		DATE
DESSINÉ PAR DRAWN BY	CLAUDIA GILBERT	2019-02-14
VÉRIFIÉ PAR CHECKED BY	SYLVAIN DÉFOSSÉ	2019-02-14
APPROUVÉ PAR APPROVED BY	DOMINIQUE RICHARD	2019-03-06
ÉCHELLE SCALE	INDICATED	DATE 2019-02-14

NO. DESSIN DRAWING NO. 65-680-210-200

NO. PROJET PROJECT NO.	REVISION	FEUILLE / SHT
6528	0	1 / 1

AE-CART-ARCH D

P:_18X-XXXX-XX\181-15686-00\01-COMM\Envoyé_AEM\WSP-AEM-181-15686-00-157 (C-265-001_RFQ Meliadine)\65-680-210-200_R0.dwg-2019-03-21 17:13:20

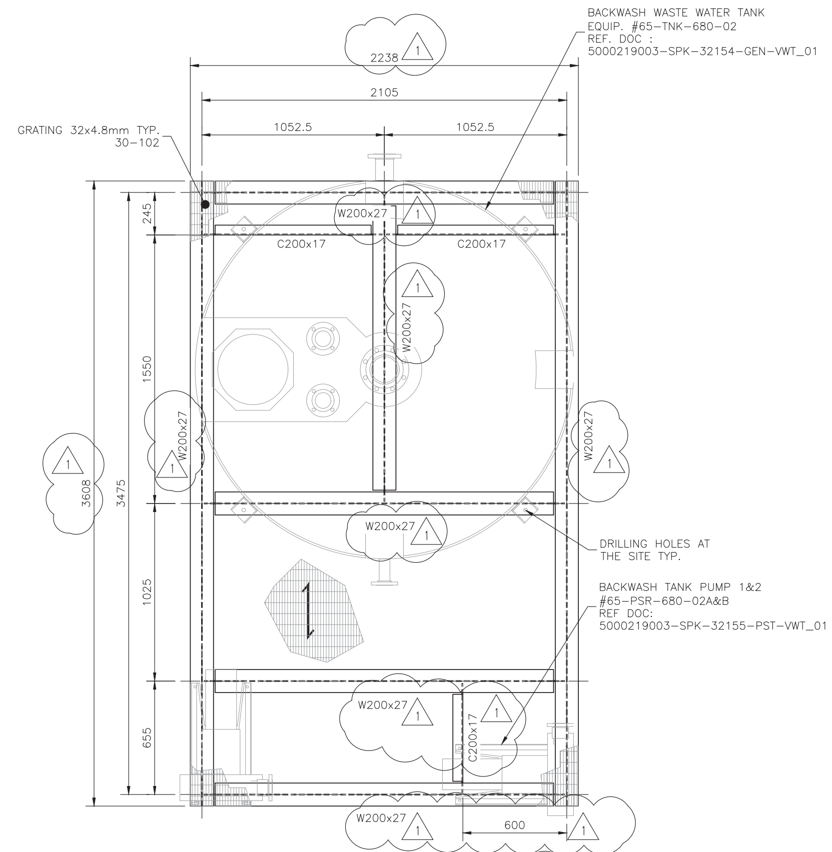
FILE NO. 65-680-210-200_R0.dwg

NO. DESSIN / DRAWING NO. 65-680-245-200_R1

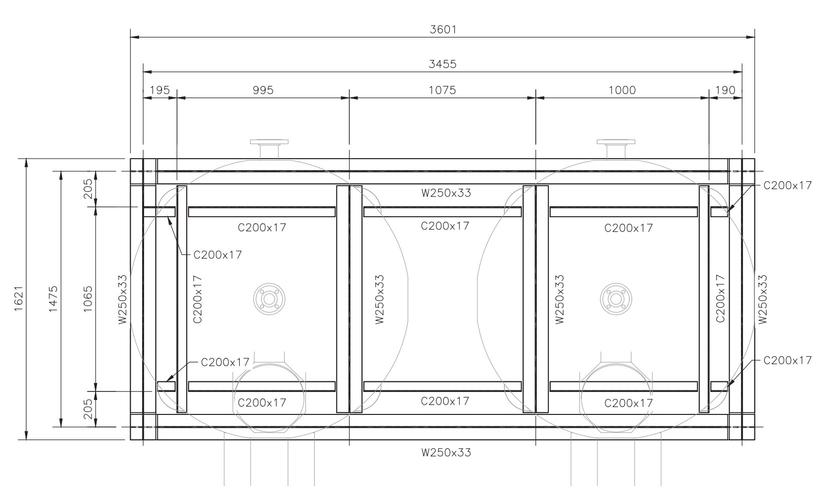
FORMAT ARCHD

LEGEND

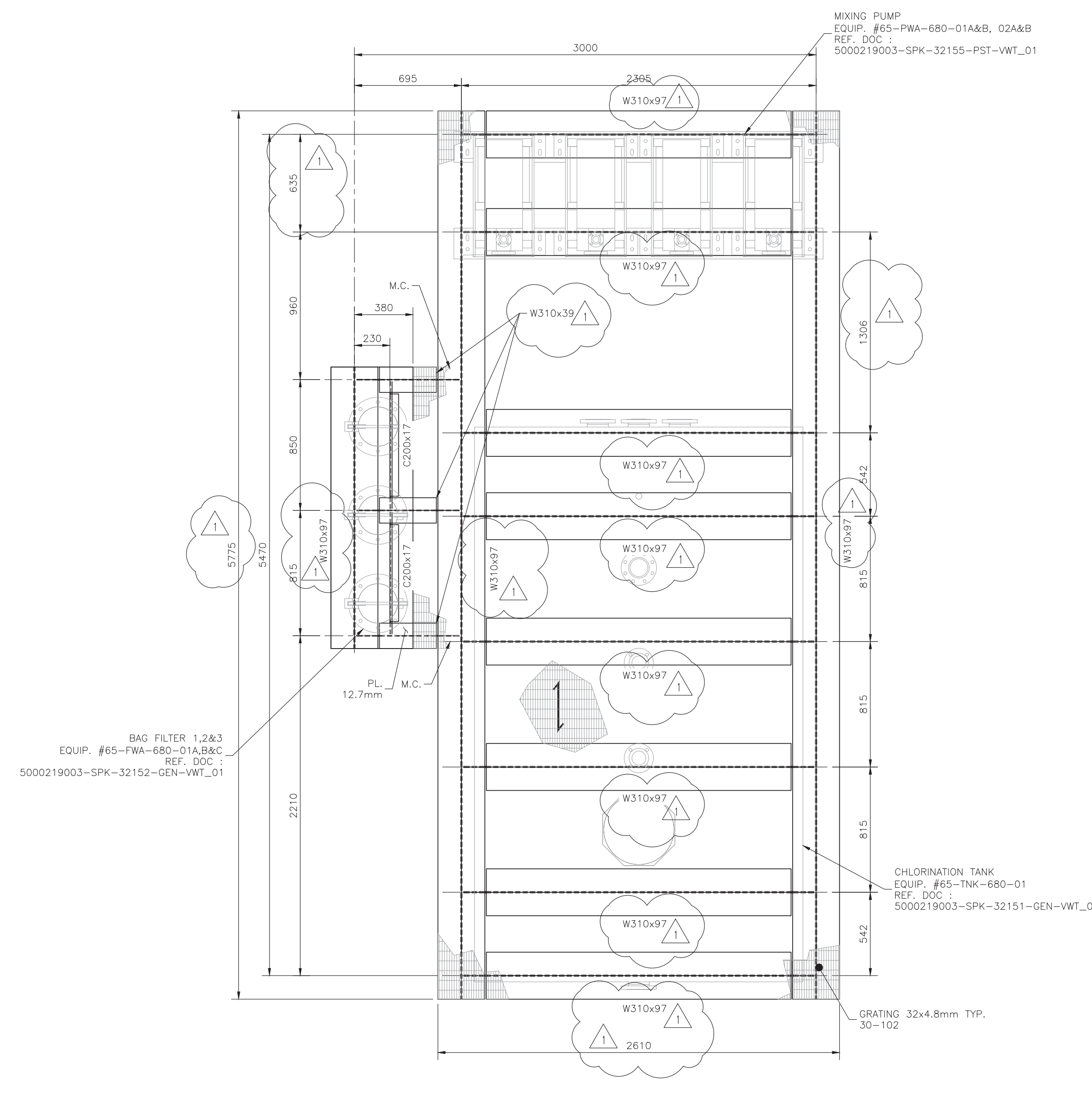
(arrow)	ORIENTATION OF GRATING
(dashed line)	BRACING
(dash-dot line)	HANDRAIL
Cf. MAX.	MAX. FACTORED COMPRES. LOAD
Tf. MAX.	MAX. FACTORED TENSION LOAD
U.O.I.	UNLESS OTHERWISE INDICATED
M.C.	MOMENT CONNECTION



DETAIL BACKWASH TANK SUPPORT 1 (680-210-200)
SCL:1:20
QTY:1



DETAIL GAC TANK SUPPORT 2 (680-210-200)
SCL:1:20
QTY:1



DETAIL CHLORINATION TANK SUPPORT 3 (680-210-200)
SCL:1:20
QTY:1

NOTE:

2. PROVIDE SECONDARY BEAM AT THE SITE FOR THE INSTALLATION OF THE GRATING.

PLAN CLÉ / KEY PLAN

wsp
1075, 3e AVENUE EST
VAL-D'OR (QUÉBEC) CANADA J9P 0J7
TÉL : 819 825-4274 | TÉLÉC. : 819 824-1514 | WWW.WSPGROUP.COM
Ref. 181-15686-00

NOTES GÉNÉRALES / GENERAL NOTES

POUR CONSTRUCTION
FOR CONSTRUCTION
AGNICO EAGLE
DATE : 24-05-2019

DESSINS EN RÉFÉRENCE / REFERENCE DRAWINGS

TITRE / TITLE	# DWG
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AGNICO EAGLE

REV.	DATE	DESCRIPTION	PAR/BY	APP.	CLIENT
1	2019-05-24	REVISION FOR CONSTRUCTION	C.G.	O.P.	
0	2019-04-26	ISSUED FOR CONSTRUCTION	C.G.	O.P.	

REVISIONS

PERREAULT — LICENSEE — NT/NU
Olivier Perreault — 124887 — QUÉBEC
2019-05-27

TITRE / TITLE
AGNICO EAGLE – MELIADINE DIVISION
680 – SALINE EFFLUENT TREATMENT PLANT
245 – STRUCTURAL STEEL
EQUIPEMENT SUPPORT
PLAN VIEW

DESSINÉ PAR / DRAWN BY	CLAUDIA GILBERT	DATE 2019-04-01
VÉRIFIÉ PAR / CHECKED BY	MARC-ANDRÉ LEPAGE, Jr. Eng.	2019-04-26
APPROUVÉ PAR / APPROVED BY	OLIVIER PERREAULT, P. Eng.	2019-04-26
ÉCHELLE / SCALE	INDICATED	DATE 2019-04-01

NO. DESSIN / DRAWING NO. 65-680-245-200

NO. PROJET / PROJECT NO.	REVISION	FEUILLE / SHT
6528	1	1 / 1

AE-CART-ARCH D

P:_18X-XXXX-XX\181-15686-00\01-COMM\Envoyé_AEM\WSP-AEM-181-15686-00-253 (RÉVISION STRUCTURE ÉQUIPEMENT)\65-680-245-200_R1.dwg-2019-05-24 12:35:48

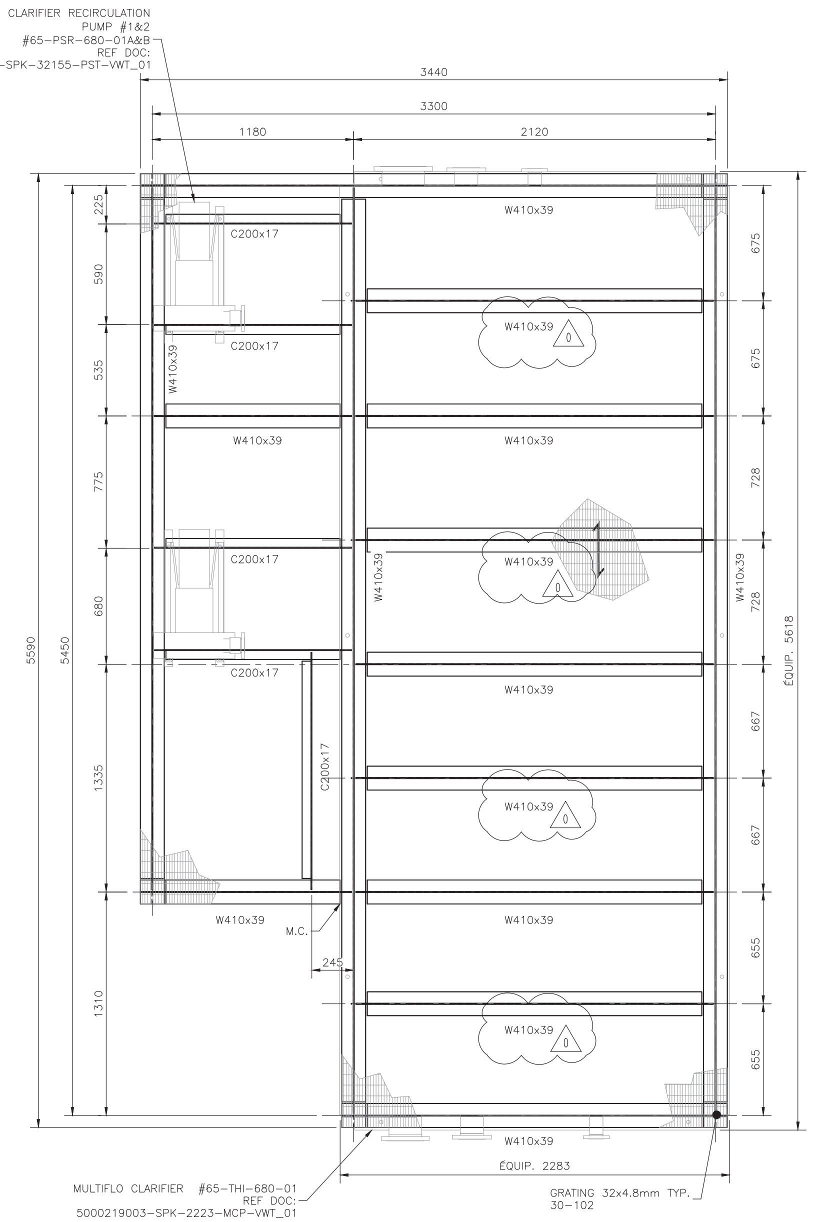
FILE NO. 65-680-245-200_R1.dwg

NO. DESSIN
DRAWING NO. 65-680-245-201_R0

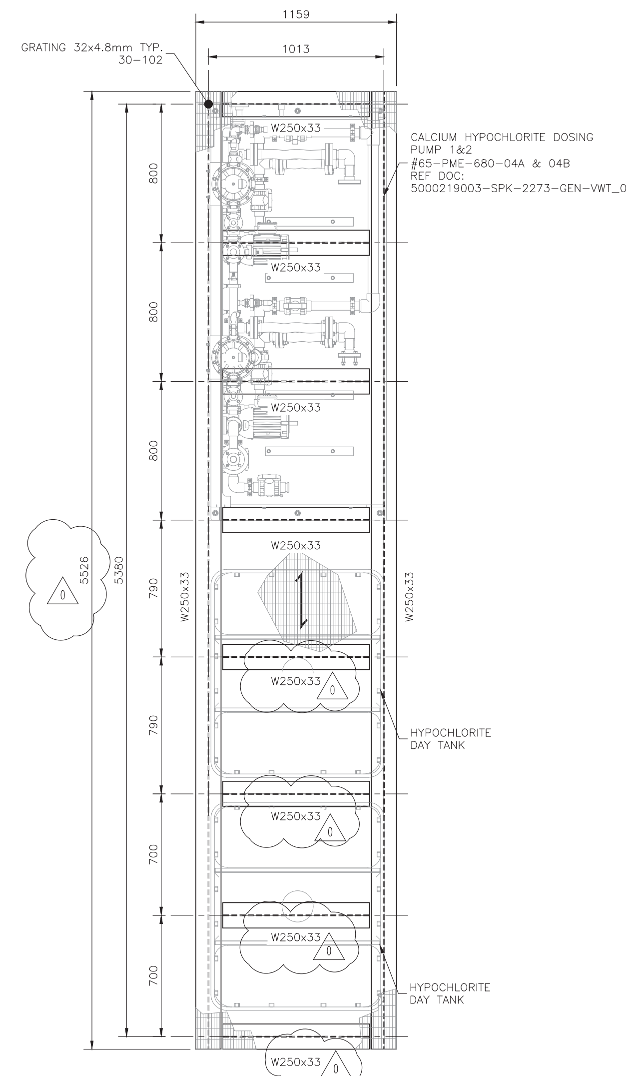
FORMAT ARCHD

LEGEND

(arrow)	ORIENTATION OF GRATING
(dashed line)	BRACING
(dash-dot line)	HANDRAIL
Cf. MAX.	MAX. FACTORED COMPRES. LOAD
Tf. MAX.	MAX. FACTORED TENSION LOAD
U.O.I.	UNLESS OTHERWISE INDICATED
M.C.	MOMENT CONNECTION



DETAIL MULTIFLO SUPPORT 4 (680-210-200)
SCL:1:20
QTY:1



DETAIL HYPOCHLORITE SKID & TOTES SUPPORT 5 (680-210-200)
SCL:1:20
QTY:1

NOTE:
2. PROVIDE SECONDARY BEAM AT THE SITE FOR THE INSTALLATION OF THE GRATING.

PLAN CLÉ
KEY PLAN

WSP
1075, 3e AVENUE EST
VAL-D'OR (QUÉBEC) CANADA J9P 0J7
TÉL. : 819 825-4274 | TÉLÉC. : 819 824-1514 | WWW.WSPGROUP.COM
Ref. 181-15686-00

NOTES GÉNÉRALES / GENERAL NOTES

POUR CONSTRUCTION
FOR CONSTRUCTION
AGNICO EAGLE
DATE : 24-05-2019

DESSINS EN RÉFÉRENCE / REFERENCE DRAWINGS

TITRE / TITLE	# DWG
-	-
-	-
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AGNICO EAGLE

REV.	DATE	DESCRIPTION	PAR/BY	APP.	CLIENT
0	2019-05-24	ISSUED FOR CONSTRUCTION	C.G.	O.P.	

REVISIONS

2019-05-27

TITRE / TITLE
AGNICO EAGLE – MELIADINE DIVISION
680 – SALINE EFFLUENT TREATMENT PLANT
245 – STRUCTURAL STEEL
EQUIPEMENT SUPPORT
PLAN VIEW

DESSINÉ PAR / DRAWN BY	CLAUDIA GILBERT	DATE 2019-04-01
VÉRIFIÉ PAR / CHECKED BY	MARC-ANDRÉ LEPAGE, Jr. Eng.	2019-04-26
APPROUVÉ PAR / APPROVED BY	OLIVIER PERREAULT, P. Eng.	2019-04-26
ÉCHELLE / SCALE	INDICATED	DATE 2019-04-01

NO. DESSIN
DRAWING NO. 65-680-245-201

NO. PROJET / PROJECT NO.	REVISION	FEUILLE / SHT
6528	0	1 / 1

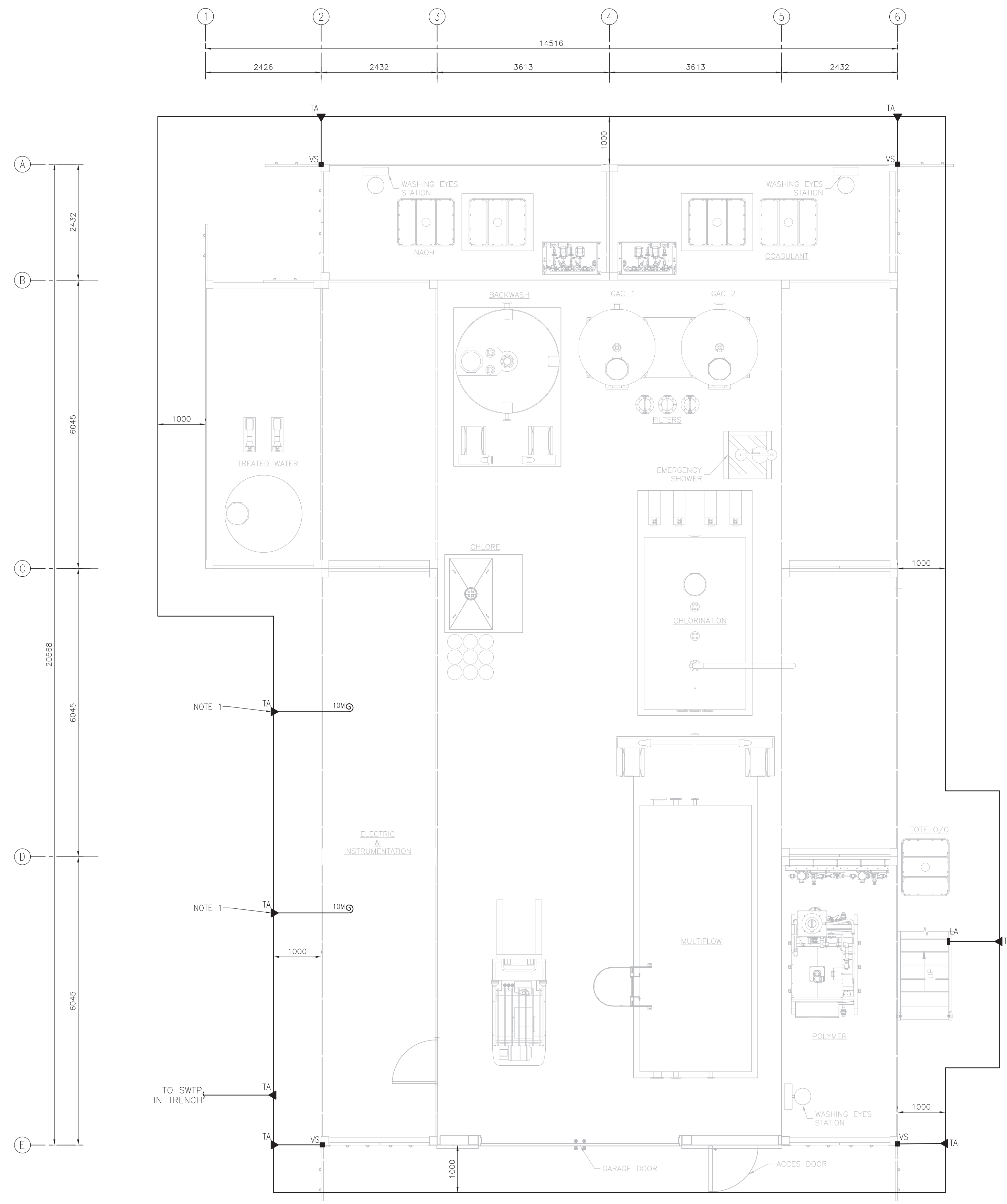
AE-CART-ARCH D

P:_18X-XXXX-XX\181-15686-00\01-COMM\Envoyé_AEM\WSP-AEM-181-15686-00-253 (RÉVISION STRUCTURE ÉQUIPEMENT)\65-680-245-201_R0.dwg-2019-05-24 12:34:46

FILE NO. 65-680-245-201_R0.dwg

NO. DESSIN DRAWING NO. 65-680-275-200_R0_XREF

FORMAT ARCHD



GROUND FLOOR
SCL: 1:50

PLAN CLÉ
KEY PLAN

WSP
1075, 3e AVENUE EST
VAL-D'OR (QUÉBEC) CANADA J9P 0J7
TÉL.: 819 825-4274 | TÉLÉC.: 819 824-1514 | WWW.WSPGROUP.COM
Ref. XXX-XXXXX-XX

NOTES GÉNÉRALES / GENERAL NOTES

NOTE:
1. GROUND EQUIPMENT INSIDE ELECTRICAL ROOM.

NE PAS UTILISER POUR CONSTRUCTION
NOT FOR CONSTRUCTION
AGNICO EAGLE DATE : 2019-03-21

DESSINS EN RÉFÉRENCE / REFERENCE DRAWINGS

TITRE / TITLE	# DWG
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AGNICO EAGLE

REV.	DATE	DESCRIPTION	PAR/BY	APP.	CLIENT
0	2019-03-21	ISSUED FOR RFQ	F.M.G.	L.S.	

REVISIONS

2019-03-21
REGISTERED PROFESSIONAL ENGINEER L.G.P. SENECAL LICENSEE NT/NU

TITRE / TITLE
AGNICO EAGLE – MELIADINE DIVISION
680 – SALINE EFFLUENT TREATMENT PLANT
275 – POWER ELECTRICAL
GROUNDING
PLAN VIEW

DESSINÉ PAR DRAWN BY	F. MONDERIE, Tech	DATE	2019-03-21
VERIFIÉ PAR CHECKED BY	LUC SÉNÉCAL, P.Eng		2019-03-21
APPROUVÉ PAR APPROVED BY	LUC SÉNÉCAL, P.Eng		2019-03-21
ÉCHELLE SCALE	INDICATED	DATE	2019-03-18

NO. DESSIN DRAWING NO. 65-680-275-200

NO. PROJET PROJECT NO.	REVISION	FEUILLE / SHT
6528	0	1 / 1

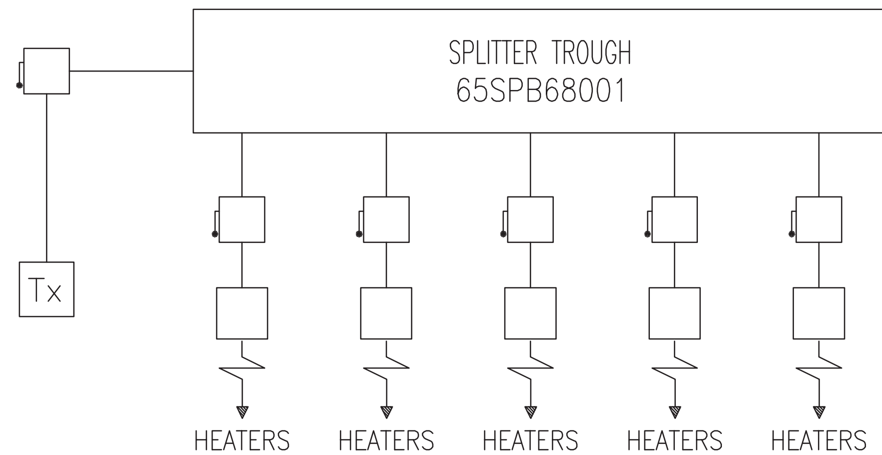
AE-CART-ARCH D

\\CaVdo1Dat01\Projet_18X-XXXX-XX\181-15686-00\03-TECH_ORANGE\Dessin\Dessin_Emis_non-lies\65-680-275-200_R0_XREF.dwg-2019-03-21 16:23:07

FILE NO. 65-680-275-200_R0_XREF.dwg

NO. DESSIN DRAWING NO.	65–680–275–201_R0

FORMAT ANSI B–11x17



PANEL No. : 65DPP68001

Tension:	600	Volts
Powered by:	681 - E-ROOM	
Installation:	SURFACE	
Location:	680 - ELECTRICAL ROOM	
Type:	I-Line	

Enclosure type	NEMA 1
Main breaker:	-
Height:	99 po
Bars:	1200 A
Ampacity:	50 kA

Local and description	TYPE REF	TYPE QTY	WATTS	BREAK. TYPE	BREAK. AMP	CT #	HEIGHT	CT #	BREAK. AMP	BREAK. TYPE	WATTS	TYPE QTY	TYPE REF	Local and description
SPLITTER TROUGH 600 V 65SPB68001	O				200 3P	1	1.5 3.0 4.5	2	15 3P				O	65VSD68012
65VSD68001	O				15 3P	3	6.0 7.5 9.0	4	15 3P				O	65VSD68013
65VSD68002	O				15 3P	5	10.5 12.0 13.5	6	15 3P				O	65VSD68014
65VSD68003	O				15 3P	7	15.0 17 18.0	8	15 3P				O	65VSD68015
65VSD68004	O				15 3P	9	19.5 21.0 22.5	10	15 3P				O	65VSD68016
65VSD68005	O				50 3P	11	24.0 25.5 27.0	12	15 3P				O	65VSD68017
65VSD68006	O				15 3P	13	29 30.0 31.5	14	15 3P				O	65VSD68018
65VSD68007	O				15 3P	15	33.0 34.5 36.0	16	15 3P				O	65VSD68019
65VSD68008	O				15 3P	17	37.5 39.0 40.5	18	15 3P				O	65VSD68020
65VSD68009	O				15 3P	19	42.0 43.5 45.0	20	15 3P					
65VSD68010	O				15 3P	21	46.5 48.0 49.5	22	15 3P					
65VSD68011	O				15 3P	23	51.0 52.5 54.0	24	15 3P					

TYPE (REF)	Total(W)	Qty
(L) Lighting	0	0
(P) Outlet	0	0
(H) Heating	0	0
(M) Motors	0	0
(W) Water heater	0	0
(O) Others	0	21

TYPE (REF)	Qty (ref)
(L) Spare	0
(S) Space	0

	Watts	Amp
Total R	0	0

NE PAS UTILISER POUR CONSTRUCTION
NOT FOR CONSTRUCTION
AGNICO EAGLE DATE : 2019–03–21

wsp
1075, 3e AVENUE EST
VAL-D'OR (QUÉBEC) CANADA J9P 0J7
TÉL. : 819 825-4274 | TÉLÉC. : 819 824-1514 | WWW.WSPGROUP.COM

Ref. 181–15868–00

TITRE / TITLE	# DWG
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DESSINS EN RÉFÉRENCE / REFERENCE DRAWINGS

REV	DESCRIPTION	DATE	PAR BY
0	ISSUED FOR RFQ	2019–03–21	L.S.

REVISIONS

AGNICO EAGLE

2019-03-21
REGISTERED PROFESSIONAL ENGINEER
L.G.P. SENECAL
LICENSEE
NT/NU

DESSINÉ PAR DRAWN BY	FANNIE MONDERIE, tech.	DATE	2019–03–21
VÉRIFIÉ PAR CHECKED BY	LUC SÉNECAL, P.Eng.		2019–03–21
APPROUVÉ PAR APPROVED BY	LUC SÉNECAL, P.Eng.		2019–03–21
No. PROJET PROJECT NO.	6528		
DATE	2019–03–18		

TITRE / TITLE
AGNICO EAGLE – MELIADINE DIVISION
680 – SALINE EFFLUENT TREATMENT PLANT
275 – POWER ELECTRICAL
600V – DISTRIBUTION PANEL
65DPP68001

ÉCHELLE/ SCALE	NONE	FICHIER FILE	65–680–275–201_R0.DWG
No. DESSIN/ DRAWING NO.	65–680–275–201	REVISION 0	FEUILLE/SHT 1 / 1

NO. DESSIN
DRAWING NO. 65-680-275-202_R0_XREF

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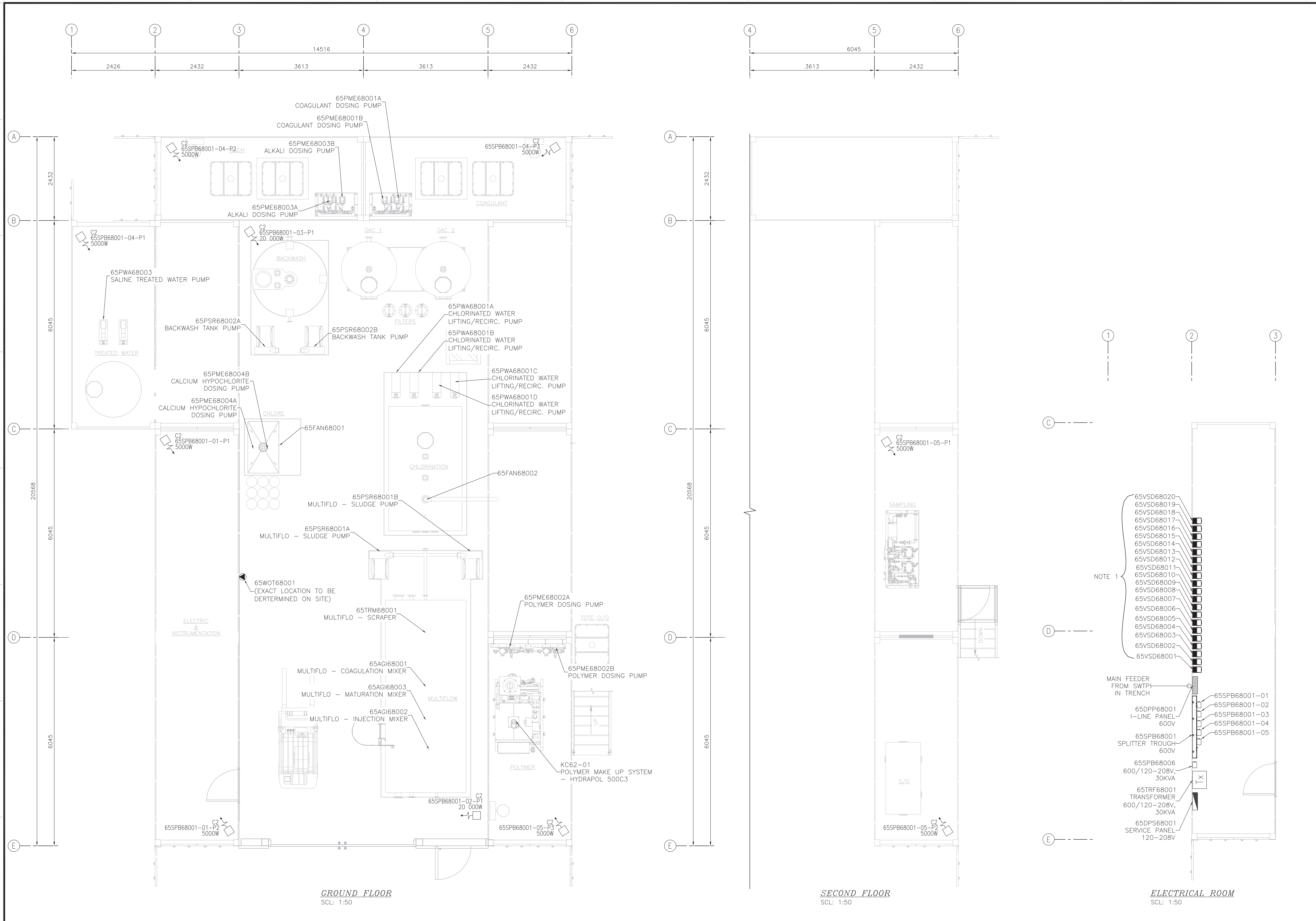

PLAN CLÉ
KEY PLAN

1075, 3e AVENUE EST
VAL-D'OR (QUÉBEC) CANADA J9P 0J7
TÉL. : 819 825-4274 | TÉLÉC. : 819 824-1514 | WWW.WSPGROUP.COM
Ref. XXX-XXXXX-XX

NOTES GÉNÉRALES / GENERAL NOTES

NOTE:
1. INSTALL WALL MOUNTED VSD ON "U" CHANNEL TO FABRICATE.

NE PAS UTILISER POUR CONSTRUCTION
NOT FOR CONSTRUCTION
AGNICO EAGLE DATE : 2019-03-21

DESSINS EN RÉFÉRENCE / REFERENCE DRAWINGS

TITRE / TITLE	# DWG
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AGNICO EAGLE

REV.	DATE	DESCRIPTION	PAR/BY	APP.	CLIENT
0	2019-03-21	ISSUED FOR RFQ	F.M.G.	L.S.	

REVISIONS

2019-03-21
REGISTERED PROFESSIONAL ENGINEER L.G.P. SENECAL LICENSEE NT/NU

TITRE / TITLE
AGNICO EAGLE – MELIADINE DIVISION
680 – SALINE EFFLUENT TREATMENT PLANT
275 – POWER ELECTRICAL
MOTOR & EQUIPMENT LOCATION
PLAN VIEW

		DATE
DESSINÉ PAR / DRAWN BY	F. MONDERIE, Tech	2019-03-21
VERIFIÉ PAR / CHECKED BY	LUC SÉNÉCAL, P.Eng	2019-03-21
APPROUVÉ PAR / APPROVED BY	LUC SÉNÉCAL, P.Eng	2019-03-21

ÉCHELLE / SCALE: INDICATED — DATE: 2019-03-18

NO. DESSIN / DRAWING NO.: 65-680-275-202

NO. PROJET / PROJECT NO.	REVISION	FEUILLE / SHT
6528	0	1 / 1

AE-CART-ARCH D

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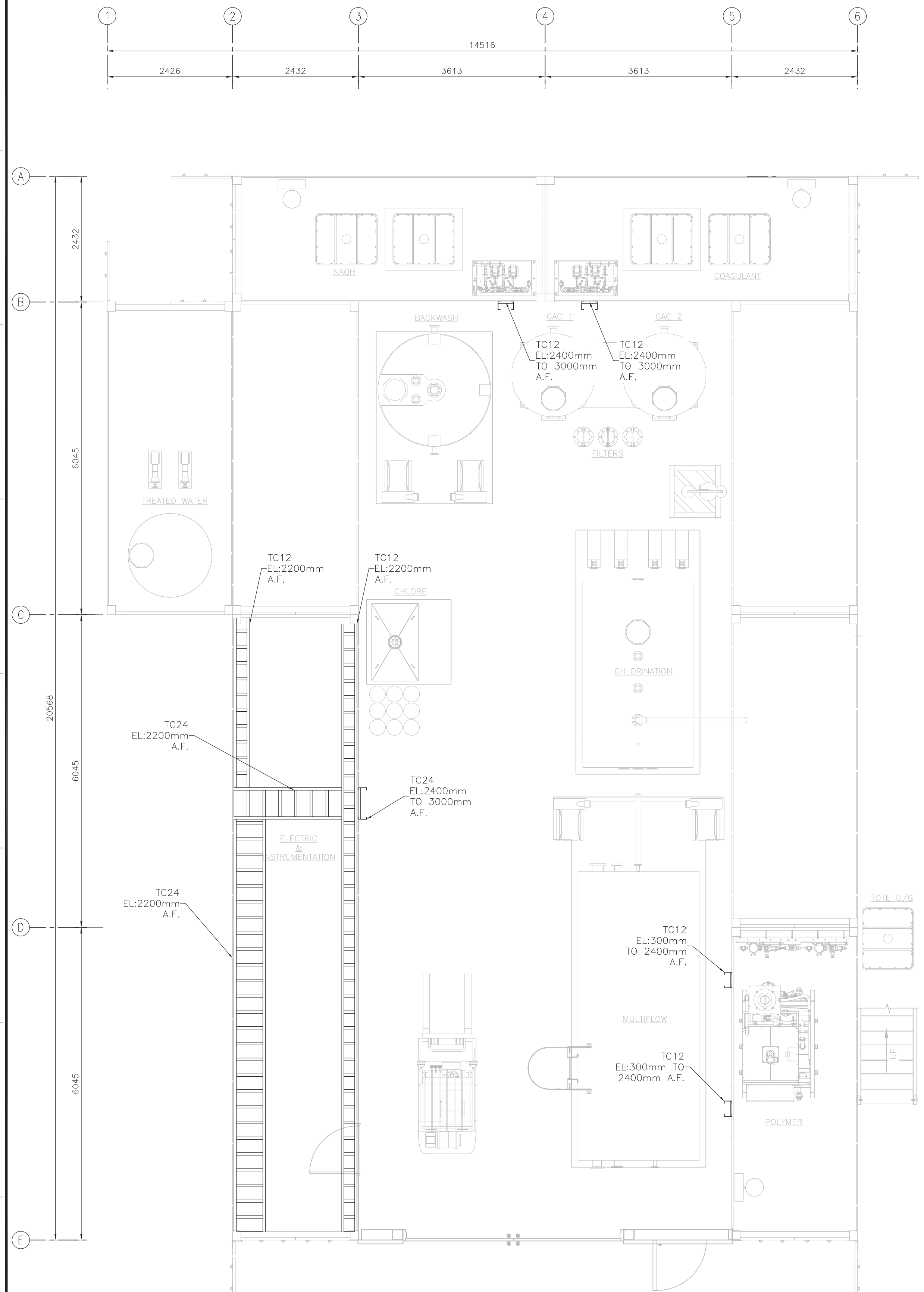
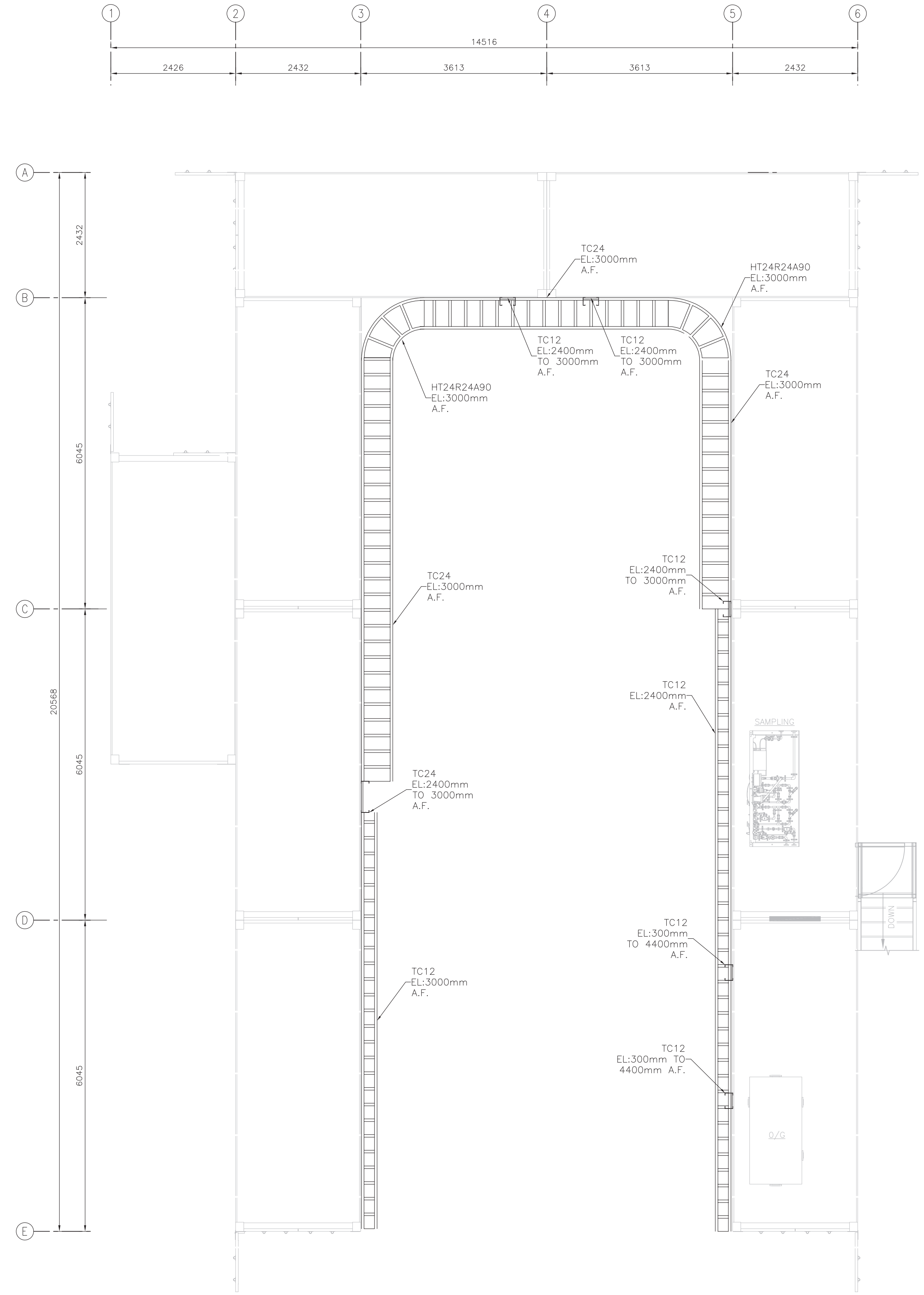
FILE NO. 65-680-275-202_R0_XREF.dwg

NO. DESSIN / DRAWING NO. 65-680-275-203_R0_XREF

FORMAT ARCHD



GROUND FLOOR
SCL: 1:50



SECOND FLOOR
SCL: 1:50

PLAN CLÉ / KEY PLAN

WSP
1075, 3e AVENUE EST
VAL-D'OR (QUÉBEC) CANADA J9P 0J7
TÉL. : 819 825-4274 | TÉLÉC. : 819 824-1514 | WWW.WSPGROUP.COM
Ref. XXX-XXXXX-XX

NOTES GÉNÉRALES / GENERAL NOTES

NE PAS UTILISER POUR CONSTRUCTION
NOT FOR CONSTRUCTION
AGNICO EAGLE DATE : 2019-03-21

DESSINS EN RÉFÉRENCE / REFERENCE DRAWINGS

TITRE / TITLE	# DWG
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AGNICO EAGLE

REV.	DATE	DESCRIPTION	PAR/BY	APP.	CLIENT
0	2019-03-21	ISSUED FOR RFQ	F.M.G.	L.S.	

REVISIONS

2019-03-21
REGISTERED PROFESSIONAL ENGINEER L.G.P. SENECAL LICENSEE NT/NU

TITRE / TITLE
AGNICO EAGLE – MELIADINE DIVISION
680 – SALINE EFFLUENT TREATMENT PLANT
275 – POWER ELECTRICAL
CABLE TRAY
PLAN VIEW

		DATE
DESSINÉ PAR / DRAWN BY	F. MONDERIE, Tech	2019-03-21
VERIFIÉ PAR / CHECKED BY	LUC SÉNÉCAL, P.Eng	2019-03-21
APPROUVÉ PAR / APPROVED BY	LUC SÉNÉCAL, P.Eng	2019-03-21

ÉCHELLE / SCALE: INDICATED — DATE: 2019-03-18

NO. DESSIN / DRAWING NO. 65-680-275-203

NO. PROJET / PROJECT NO. 6528 — REVISION 0 — FEUILLE / SHT 1 / 1

AE-CART-ARCH D

\\CaVdo1Dot01\Projet_18X-XXXX-XX\181-15686-00\03-TECH_ORANGE\Dessin\Dessin_Emis_non-liés\65-680-275-203_R0_XREF.dwg-2019-03-21 16:23:29

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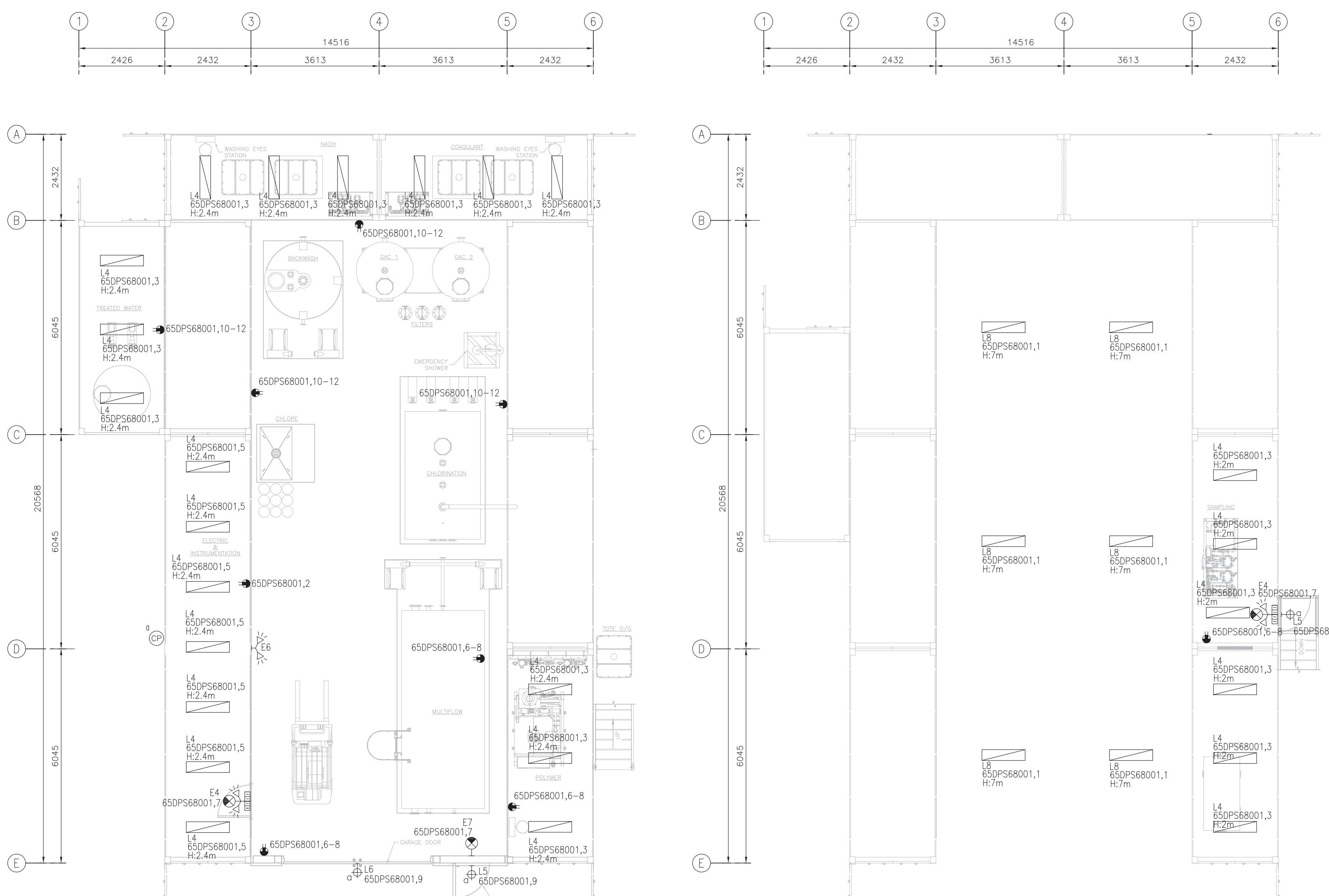
NO. DESSIN DRAWING NO. 65-680-285-200_R0_XREF

FORMAT ARCHD



GROUND FLOOR
SCL: 1:75

SECOND FLOOR
SCL: 1:75

PANEL No. : 65DPS68001

Tension:	120 208 Volts
Powered by:	65TRF68001
Installation:	SURFACE
Location:	680 E-ROOM
Type:	NQ442L2AL

Enclosure type	NEMA 1
Main breaker:	-
No. of circuits:	42 CCTs
Bars:	225 A
Ampacity:	10 kA

Local and description	TYPE REF	TYPE QTY	WATTS	BREAK. TYPE	BREAK. AMP	CT #		CT #	BREAK. AMP	BREAK. TYPE	WATTS	TYPE QTY	TYPE REF	Local and description
LIGHTING	L	6	1092		15	1	A	2	2P		120	1	P	OUTLET ELECTRICAL ROOM
LIGHTING	L	18	864		15	3	B	4	20		120	1	P	
LIGHTING ELECTRICAL ROOM	L	7	336		15	5	C	6	2P		480	4	P	OUTLET
L.EMERGENCY LIGHTING	L	3	360		15	7	A	8	20		480	4	P	
L.OUTDOOR LIGHTING	L	3	181		15	9	B	10	2P		480	4	P	OUTLET
				L	15	11	C	12	20		480	4	P	
				L	15	13	A	14	20	L				
				L	15	15	B	16	20	L				
				L	15	17	C	18	20	L				
				L	15	19	A	20	20	L				
				L	15	21	B	22	20	L				
				L	15	23	C	24	20	L				
				L	15	25	A	26	20	L				
				L	15	27	B	28	20	L				
				L	15	29	C	30	20	L				
				L	15	31	A	32	20	L				
				L	15	33	B	34	20	L				
				S		35	C	36		S				
				S		37	A	38		S				
				S		39	B	40		S				
				S		41	C	42		S				

TYPE (REF)	Total(W)	Qty
(L) Lighting	2833	5
(P) Outlet	2160	6
(H) Heating	0	0
(M) Motors	0	0
(W) Water heater	0	0
(O) Others	0	0

TYPE (REF)	Qty (ref)
(L) Spare	23
(S) Space	8

	Watts	Amp
Phase A	2052	17.10
Phase B	1645	13.71
Phase C	1296	10.80
Total R	4993	13.86

PLAN CLÉ
KEY PLAN

1075, 3e AVENUE EST
VAL-D'OR (QUÉBEC) CANADA J9P 0J7
TÉL. : 819 825-4274 | TÉLÉC. : 819 824-1514 | WWW.WSPGROUP.COM

Ref. XXX-XXXXX-XX

NOTES GÉNÉRALES / GENERAL NOTES

NE PAS UTILISER POUR CONSTRUCTION
NOT FOR CONSTRUCTION
AGNICO EAGLE DATE : 2019-03-21

DESSINS EN RÉFÉRENCE / REFERENCE DRAWINGS

TITRE / TITLE	# DWG
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AGNICO EAGLE

REV.	DATE	DESCRIPTION	PAR/BY	APP.	CLIENT
0	2019-03-21	ISSUED FOR RFQ	F.M.G.	L.S.	

REVISIONS

2019-03-21
REGISTERED PROFESSIONAL ENGINEER L.G.P. SENECAL LICENSEE NT/NU

TITRE / TITLE
AGNICO EAGLE – MELIADINE DIVISION
680 – SALINE EFFLUENT TREATMENT PLANT
285 – SERVICES ELECTRICAL
LIGHTING AND SERVICES
PLAN VIEW

DESSINÉ PAR DRAWN BY	FANNIE MONDERIE, tech.	DATE 2019-03-21
VERIFIÉ PAR CHECKED BY	LUC SÉNÉCAL, P.Eng	2019-03-21
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6528	0	1 / 1

Appendix B: Functional description

Functional Description
Saline Effluent Treatment Plant (SETP)

Appendix B

			Sébastien Perron Instrumentation 2019.05.16 16:50:03 -05'00'	Sébastien Perron Instrumentation 2019.05.21 08:12:41 -05'00'	Éric Lavoie 2019.05.21 09:23:35 -04'00'
2019-04-24	R0	For design report	Sebastien Perron	Alain Corriveau	Éric Lavoie
Date	**Rev.**	**Status**	**Prepared by**	**Checked by**	**Accepted by**

TABLE OF CONTENTS

1 INTRODUCTION

The following document describes the typical operation of the Saline effluent treatment plant (SETP) itself, sludge system, treated water system, service water system. The functional description includes also the chemical dosing system.

2 PLC

The main PLC Panel (65PLC68001) which will control the system will be located in the Saline Effluent Treatment Plant electrical room. This panel will control the system feed pumps, oil and grease separator, Multiflo clarifier, break point chlorination, cartridge filters, carbon filters, saline mixing tank and submersible pumps to fill trucks, as well as reagents.

Another PLC (65PLC680002), supplied by Veolia, will control the polymer dosing skid.

The fresh water addition feed for mixing is controlled by an existing PLC (65PLC69301) in the Effluent Water Treatment Plant. Communication will be made through an existing fiber optic network on site.

The measurement for water quality prior to loading the truck will be connected in a remote I/O (65IOP68001) located in a pumping station beside the truck connection. This remote I/O is connected to the main PLC via optic fiber.

3 HMI

Three Schneider Magelis HMI will be installed, one on main PLC panel (65HMI68011), one on field close to the Multiflo Clarifier (65HMI68001), one on remote I/O panel in truck filling station (65HMI68021).

65HMI68001 and 65HMI68011

Screen 1: Feed, Oil and Grease Separator

- SWTP Raw Water Pump (65PWA68108)
- SWTP Raw Water Level Transmitter (65LT6810401)
- SWTP Raw Water Pump Flowmeter (65FIT6800154) and his accumulator (65FQI6800154)
- Oil Separator High Level Switch (65LSH6800153)

Screen 2: Multiflo Clarifier

- Coagulation Tank Agitator (65AGI68001)
- Injection Tank Agitator (65AGI68002)
- Maturation Tank Agitator (65AGI68003)
- Multiflo Clarifier Rake (65TRM68001)
- Multiflo Clarifier Rake High Torque Switch (65OSHH6800117)
- Multiflo Clarifier High Level Switch (65LSH6800116)
- Multiflo Clarifier Recirculation Pumps (65PSR68001A and B) and their broken tube detectors
- Multiflo Clarifier Recirculation Flowmeter (65FIT6800127) and Control Valve (65FCV6800127)

- Sludge Discharge Valve (65FV6800128)
- Sludge Discharge Flowmeter (65FIT68000128) and his accumulator (65FQI6800128)

Screen 3: Chlorination Tank

- Chlorination Tank Feed Valve (65FV6800224)
- Chlorination Tank Level (65LIT6800241)
- Chlorination Tank Exhaust Fan (65FAN68001)
- Chlorination Tank Mixing Pumps (65PWA68001A, 01B, 02A, 02B)
- Chlorination Tank Mixing Pumps Pressure Transmitter (65PIT6800263)
- Chlorine Analyzer (65AIT6800275)

Screen 4: Filtration

- Saline Treated Water Transmitter (65FIT6800342) and his accumulator (65FQI6800342)
- Saline Treated Water Tank Valve (65FV6800343)
- Recirculation Valve to Chlorination Tank (65FV6800344)
- Backwash Waste Water Tank Level Transmitter (65LIT6800326)
- Backwash Tank Pumps (65PSR68002A and B) and their broken tube detectors

Screen 5: Saline Treated Water Mix

- Fresh Water Flow Transmitter (65FIT6800606) and his accumulator (65FQI6800606)
- Fresh Water Flow Control Valve (65FCV6800606)
- SWTP Treated Water Level Transmitter (65LT6813231)
- SWTP Treated Water Pump (65PWA68107)
- Saline Treated Water Tank Level Transmitter (65LIT6800611)
- Saline Treated Water Pump (65PWA68003)
- Mixed Water Flow Transmitter (65FIT6800619) and his accumulator (65FQI6800619)
- SP3 Pond Level Transmitter (65LT6800627)

Screen 6: Pumping Station (view only, controlled from 65HMI68021)

- Pumping Station Pumps (65PSU68001A and B)
- SP3 Pond Level Transmitter (65LT6800627)
- Pumping Station Pressure Transmitter (65PIT6800640)
- Pumping Station Flow Transmitter (65FIT6800629) and his accumulator (65FQI6800629)
- Pumping Station Indicating Lights Red and Green (65YL6800629A and B)

Screen 7: Samplers

- Multiflo Clarifier Feed Total Suspended Solid Analyzer (65AIT6800102)

- ---
- Multiflo Clarifier Overflow Turbidity Analyzer (65AIT6800119)
- Multiflo Clarifier Overflow PH Analyzer (65AIT6800362)
- Multiflo Clarifier Overflow TOC Analyzer (65AIT6800370)
- Multiflo Clarifier Overflow NH3 Analyzer (65AIT6800372)
- ---
- Multiflo Clarifier Recirculation Total Suspended Solid Analyzer (65AIT6800126)
- ---
- Chlorination Tank PH Analyzer (65AIT6800268)
- Chlorination Tank Temperature (65TE6800268)
- Chlorination Tank Total Chlorine Analyzer (65AIT6800266)
- Chlorination Tank Chlorine Analyzer (65AIT6800264)
- Chlorination Tank TOC Analyzer (65AIT6800370)
- Chlorination Tank NH3 Analyzer (65AIT6800372)
- ---
- Saline Treated Water Total Chlorine Analyzer (65AIT6800341)
- Saline Treated Water Total Suspended Solid Analyzer (65AIT6800371)
- Saline Treated Water PH Analyzer (65AIT6800361)
- Saline Treated Water TOC Analyzer (65AIT6800370)
- Saline Treated Water NH3 Analyzer (65AIT6800372)
- ---
- Mixed Water Conductivity Analyzer (65AIT6800618)
- ---
- Pumping Station PH Analyzer (65AIT6800640)
- Pumping Station Conductivity Analyzer (65AIT6800641)
- Pumping Station Turbidity Analyzer (65AIT6800642)
- Pumping Station Temperature Transmitter (65TE6800645)

Screen 9: Reagents

Coagulant

- Coagulant Dosing Pumps(65PME68001A and B)

Polymer – TBC with Veolia's PLC/HMI

- Polymer Loading Hopper Low Level Switch (65LSL6800432)
- Polymer Feeder Solenoid Valve (65FY6800422)
- Polymer Make-Up Water Low Pressure Switch (65PLS6800432)

- Polymer Make-Up Water Valve (65FV6800434)
- Polymer Maturation Tank Level Transmitter (65LT6800442)
- Polymer Transfer Valve (65FV6800443)
- Polymer Dosage Tank Level Transmitter (65LT6800447)
- Polymer Dosing Pumps (65PME68002A and B)
- Polymer Dosing Pumps Temperatures (65TE6800451 and 0461)
- Polymer Dosing Pumps Water Valve (65FY6800466)
- System Run Command
- System Status and Alarms

Alkali

- Alkali Dosing Pumps(65PME68003A and B)

Sodium Hypochlorite

- Chlorine Analyzer (65AIT6800275)
- Sodium Hypochlorite Tank Low Level Switch (65LSL6800545)
- Sodium Hypochlorite Dosing Pumps Flow Meter (65FIT6800549)
- Sodium Hypochlorite Dosing Pumps (65PME68004A and B)

Screen 10: Gaz Detection

- Chlorine Analyzer (65AIT6800275)

65HMI68021

Screen 1: Pumping Station (view only, controlled from 65HMI68021)

- Pumping Station Pumps (65PSU68001A and B)
- SP3 Pond Level Transmitter (65LT6800627)
- Pumping Station Pressure Transmitter (65PIT6800640)
- Pumping Station Flow Transmitter (65FIT6800629) and his accumulator (65FQI6800629)
- Pumping Station Indicating Lights Red and Green (65YL6800629A and B)

4 MOTOR CONTROL

Saline Treatment Plant will be operated locally only. Monitoring only will be done remotely.

Manual Mode: the control room operator will operate equipment using the HMI screen start and stop button. This mode considers safety, mechanical and process interlocks. The Local/Remote selector must be set to Remote mode.

Auto mode: the equipment is operated by the PLC based on field conditions. This mode considers safety, mechanical and process interlocks. The Local/Remote selector must be set to Remote mode.

<u>Local Mode Operation:</u> This Mode is used by operation locally. In this mode the operator will select between the Auto mode or Manual mode. Reset Button and Interlock button and conventional start and stop.

Fig 1 shows Local Operation mode on HMI Local.

<u>Remote mode:</u> This mode is used by the control room operator. It will not be used in Saline Treatment Plant since everything will be operated locally.

Fig 2 shows Remote mode on HMI Local. In this mode the start button is not functional, and the stop button is used as an E-Stop and give an alarm on the control room HMI. This mode will not be used for Saline Treatment Plant since it will always be operated locally.

<u>Local mode Maintenance:</u> This mode permits operation of the equipment locally without any process interlocks. Safety and mechanical interlocks remain. This mode is used primarily for maintenance purposes. In order to switch an equipment to Local maintenance mode, the maintenance technician must communicate with the control room operator and request that the control room operator make the switch to Local Maintenance mode. When maintenance is complete, the control room operator must be contacted again to return to remote mode to give full control to control room operator.

Fig 3 shows Local Maintenance mode on HMI Local. In this mode the start button is used as a jog button, the stop button is used as a conventional Stop. The start button can easily be set as a conventional start button.

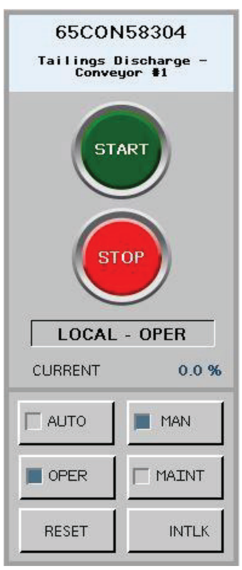


Fig 1 Local Operation

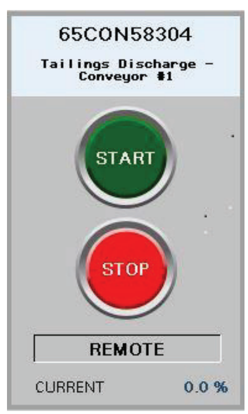


Fig 2 Remote Operation

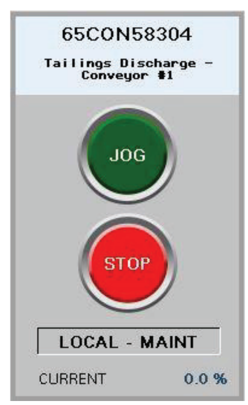


Fig 3 Maintenance

5 OPERATION

5.1 FEED, OIL AND GREASE SEPARATOR

Water to be treated is pumped from the SWTP Raw Water Tanks. The speed of the pump is controlled with a flow loop (65FIC6800154). The Pump will stop under these circumstances:

- SWTP Raw Water Tank Low Level (65LAL6810401)
- Oil Separator High Level Switch (65LSH6800153)
- Multiflo Clarifier High Level Switch (65LSH6800116)

- Chlorination Tank High Level (65LAHH6800241)
- Recirculation mode to chlorination tank for off-spec water (65ZSC6800343)

5.2 MULTIFLO CLARIFIER MORE DETAILS WITH VEOLIA FUNCTIONAL DESCRIPTION (APPENDIX)

Polymers and Coagulent are added to the tank in order to clarify water. The Multiflo Clarifier is equipped with three agitators one rake and two pumps. Coagulation Tank Agitator (65AGI68001), Injection Tank Agitator (65AGI68002), Maturation Tank Agitator (65AGI68003). These agitators will be stopped in case of Low Current Alarm (IALL). Multiflo Clarifier Rake (65TRM68001) will stop hardwired on activation of Multiflo Clarifier Rake High Torque Switch (65OSHH6800117). Multiflo Clarifier High Level Switch (65LSH6800116) will stop feed pump. Multiflo Clarifier Recirculation Pumps (65PSR68001A and B) pump sludge through Multiflo Clarifier Recirculation Flowmeter (65FIT6800127) and Control Valve (65FCV6800127) where turbidity of sludge is analyzed. When turbidity is high enough, the recirculation valve will close and Sludge Discharge Valve (65FV6800128) open in order to discharge high turbidity water. Discharged water is calculated using Sludge Discharge Flowmeter (65FIT68000128) and his accumulator (65FQI6800128).

5.3 CHLORINATION TANK MORE DETAILS WITH VEOLIA FUNCTIONAL DESCRIPTION (APPENDIX)

Multiflo Clarifier Overflow is sent to Chlorination Tank by Chlorination Tank Feed Valve (65FV6800224). Sodium Hypochlorite in injected in tanks in order to remove NH4 and TOC. Level in tank is controlled with Chlorination Tank Level Controller (65LIC6800241) and the speed of Chlorination Tank Mixing Pumps (65PWA680002A and 02B)

5.4 FILTRATION MORE DETAILS WITH VEOLIA FUNCTIONAL DESCRIPTION (APPENDIX)

Filters are only operated manually. Pressure Indicators and manual valves are installed before and after each filter so the operator can manually start a backwash.

When Operator makes backwash, the water is sent to Backwash Waste Water Tank and then pumped back to Multiflo Clarifier.

The Backwash Waste Water Tank Level Controller (65LIC6800326) sets the speed of Backwash Tank Pumps (65PSR68002A and B) in order to have a constant level in the tank.

When Saline Treated Water is inside limits in terms of Turbidity, PH, NH3, TOC, it will be sent to Saline Treated Water Tank with Saline Treated Water Tank Valve (65FV6800343). If water is set Off-Spec, it will be recirculated to Chlorination Tank with Recirculation Valve to Chlorination Tank (65FV6800344). This will also stop SWTP Raw Water Pump (65PWA68108) and close Chlorination Tank Feed Valve (65FV6800224)

5.5 SALINE TREATED WATER MIX

Treated water will be pumped in Saline Treated Water Tank and then pumped to Saline Mixer and SP3 Pond through Saline Treated Water Pump (65PWA68003). This pump speed will be controlled by the Saline Treated Water Tank Level Controller (65LIC6800611).

Fresh water from EWTP will be added to the tank, measured with the Fresh Water Flow Transmitter (65FIT6800606), controlled with Fresh Water Flow Control Valve (65FCV6800606) with a ratio of the Saline Treated Water Transmitter (65FIT6800342) and fine-tuned with the Mixed Water Conductivity Analyzer (65AIT6800618). SWTP Treated Water Pump (65PWA68107) will occasionally pump into the Saline Treated Water Tank, when so, the ration is adjusted and Mixed Water Conductivity Analyzer (65AIT6800618) will continue to fine-tune the opening of the Fresh Water Flow Control Valve

(65FCV6800606). Since we have a good idea of salt concentration, this control loop is more stable and safer if the ever conductivity sensor fail. Total water sent to SP3 pond is measured by Mixed Water Flow Transmitter (65FIT6800619) and his accumulator (65FQI6800619).

5.6 PUMPING STATION (VIEW ONLY, CONTROLLED FROM 65HMI68021)

The Pumping Station Pumps (65PSU68001A and B) are submersible pumps installed in SP3 Pond. They will be controlled by Start and Stop button on 65HMI68021 screen, as well as a Pumping Station Pressure Controller (65PIC6800640). The SP3 Pond Low Level (65LL6800627) and Pumping Station High Pressure Alarm (65PAHH6800640) will stop the pumps.

These pumps are used to fill the Tanker Truck to Itivia. In a container are installed Pumping Station Water PH Analyzer (65AIT6800640), Pumping Station Conductivity Analyzer (65AIT6800641), Pumping Station Turbidity Analyzer (65AIT6800642), Pumping Station Temperature Transmitter (65TE6800645). These instruments are used to record water quality and stop the pump in case water is off spec.

The Pumping Station Flow Transmitter (65FIT6800629) and his accumulator (65FQI6800629) are used to limit the amount of water sent in trucks each day. A counter will limit pumping to 800 cum each day and will reset after each shift. The Pumping Station Indicating Lights Red and Green (65YL6800629A and B) indicate if trucks can fill or not. The flowmeter will also prevent the truck to overfill; it will automatically stop the pump after 38 cum.

The Operator will connect his truck to the hose, open manual valves, and start the pump from inside the Pumping Station. He will be able to stop the pumps from the touch screen.

5.7 SAMPLERS

Each signal is brought in a PLC algorithm to control and dose each reagent. Alkali, Polymer, Chlorine...

Multiflo Clarifier Feed Total Suspended Solid Analyzer (65AIT6800102)

Multiflo Clarifier Overflow Turbidity Analyzer (65AIT6800119)

Multiflo Clarifier Recirculation Total Suspended Solid Analyzer (65AIT6800126)

Control Coagulant and Polymer Dosing Pumps

Multiflo Clarifier Overflow PH Analyzer (65AIT6800362)

Chlorination Tank PH Analyzer (65AIT6800268)

Control Alkali Dosing Pumps

Multiflo Clarifier Overflow TOC Analyzer (65AIT6800370)

Chlorination Tank TOC Analyzer (65AIT6800370)

Multiflo Clarifier Overflow NH3 Analyzer (65AIT6800372)

Chlorination Tank NH3 Analyzer (65AIT6800372)

Control Chlore Dosing Pumps

Chlorination Tank Temperature (65TE6800268)

Chlorination Tank Total Chlorine Analyzer (65AIT6800266)

Chlorination Tank Chlorine Analyzer (65AIT6800264)

Display and alarm only

Saline Treated Water Total Chlorine Analyzer (65AIT6800341)

Saline Treated Water Total Suspended Solid Analyzer (65AIT6800371)

<u>Saline Treated Water PH Analyzer (65AIT6800361)</u>

<u>Saline Treated Water TOC Analyzer (65AIT6800370)</u>

<u>Saline Treated Water NH3 Analyzer (65AIT6800372)</u>

Set water to Off-Spec and recirculate to Chlorination Tank. Stop Feed Pump.

<u>Mixed Water Conductivity Analyzer (65AIT6800618)</u>

Fine-tune the addition of fresh water for the Saline Water Treated Tank and Saline Mixer

<u>Pumping Station Water PH Analyzer (65AIT6800640)</u>

<u>Pumping Station Conductivity Analyzer (65AIT6800641)</u>

<u>Pumping Station Turbidity Analyzer (65AIT6800642)</u>

<u>Pumping Station Temperature Transmitter (65TE6800645)</u>

Sets Water to Off-Specs and stop Pumping Station Pumps

5.8 REAGENTS

Coagulant

Coagulant Dosing Pumps (65PME68001A and B) pump in Multiflo Clarifier Feed Pipe and will be controlled by Multiflo Clarifier Feed Total Suspended Solid Analyzer (65AIT6800102) and Multiflo Clarifier Overflow Turbidity Analyzer (65AIT6800119).

Polymer – *more details with Veolia Functional Description (appendix)*

Polymer System is supplied by Veolia and has his own PLC (65PLC68002). A vacuum conveyor will take polymer bags to a mixing tank then a distribution tank.

Polymer dosing pumps (65PME68002A) pump in Multiflo Clarifier and will be controlled by Multiflo Clarifier Feed Total Suspended Solid Analyzer (65AIT6800102) and Multiflo Clarifier Overflow Turbidity Analyzer (65AIT6800119).

Alkali

Alkali Dosing Pumps (65PME68003A and B) pump into Chlorination Tank and are controlled by Multiflo Clarifier Overflow PH Analyzer (65AIT6800362), Chlorination Tank PH Analyzer (65AIT6800268) and Saline Treated Water PH Analyzer (65AIT6800361).

Sodium Hypochlorite

Sodium Hypochlorite Pumps (65PME68004A and B) will be controlled by NH3 concentration in Multiflo Clarifier Ammonia Analyzer (65AIT6800372A), Chlorination Tank Ammonia Analyzer (65AIT6800372B) and Saline Treated Water Ammonia Analyzer (65AIT6800372C).

5.9 GAZ DETECTION

Chlorine Analyzer (65AIT6800275) will give a local and remote alarm in case of high concentration.

6 APPENDIX

Veolia System functional description

PROCESS FUNCTIONAL DESCRIPTION

Agnico Eagle Mines Limited

WATER TREATMENT PLANT- AMMONIA REMOVAL USING BREAKPOINT CHLORINATION

Rev. 1

VEOLIA WATER TECHNOLOGIES CANADA

www.veoliawatertechnologies.com

WATER TECHNOLOGIES

REVISION STATUS

Issue	Date	Created	Reviewed	Approved	Description of Changes
1	2019/02/25	MD	GP	GP	First Issue

TABLE OF CONTENTS

1 INTRODUCTION

1.1 Project Definition

Veolia Water Technologies Canada (VWTC) was contracted by Agnico Eagles Mines (A.E.M.) to supply the equipment for a mining effluent treatment.

VWTC is responsible for the supply of mechanical equipment and the control system.

This control narrative shall be read in conjunction with the related documents as listed in Section 1.3.

1.2 Process Summary

The treatment system proposed will consist of the following steps:

- TSS Removal with MULTIFLO® Settler
- Ammonia oxidation with chlorination
- Chlorine removal with granulated activated carbon

1.2.1 Multiflo® Settler

The purpose of this step is to remove TSS to protect the GAC filter.

The raw water will be pumped in a MULTIFLO® Clarifier. The proposed MULTIFLO® is designed to remove suspended solids presents in the water. The proposed MULTIFLO® has four chambers. The water flows to the first chamber, the coagulation chamber, where a coagulant is injected. The aluminium based coagulant forms a floc of aluminium hydroxide ($Al(OH)_3$) which acts as a bridge to tie colloidal particles together. The water then flows into the second chamber, the injection tank, where an anionic polymeric flocculant is added to initiate floc formation. These serve as a "seed" for floc formation and development in the next process step. From the injection tank, the water underflows to a third tank section called the maturation tank. In this section, the sludge flocs agglomerate and grow into high-density. The water then flows to the settling tank, equipped with a lamella, which provides the rapid and effective removal of the sludge floc. The clarified water exits the system via a weir. The clarified water will have a monthly average concentration of TSS of less than 15 mg/L.

The sludge settles to the bottom of the clarifier. Scrapers force the sludge collected at the bottom of the clarifier into a centre cone from which it is continuously withdrawn. Part of the sludge will be recycled to the Copper Removal Reactor, and part will be extracted for disposal. The sludge will have a dry content of about 1 to 3 %.

1.2.2 Ammonia Oxidation

The raw water is sent to a reaction tank where calcium hypochlorite and an alkali (mix of NaOH/KOH) are added. The calcium hypochlorite is a compound added to oxidize the ammonia (NH_4^+) into nitrogen (N_2). The calcium hypochlorite feed is added as a function of nitrites (NO_2^-) and ammonia concentration in the raw water.

The calcium hypochlorite injected in the water produces hypochlorous acid (HOCl). The hypochlorous acid is a weak acid, and part of the hypochlorous acid is decomposed in water into hypochlorite ions (OCl-) depending of the pH. The pH can be adjusted to optimize the chlorine dosage.

The hypochlorous acid and hypochlorite ions in solution will first be consumed by reducing agents and organic matter contained in the water. When more calcium hypochlorite is added in solution and there is a presence of ammonia, the ammonia will react to form chloramines, specifically monochloramines (NH_2Cl). When the quantity of calcium hypochlorite is sufficient, the monochloramine will be destroyed, and depending of the concentration, will be transformed in dichloramines ($NHCl_2$) or trichloramines (NCl_3) and then, finally, in nitrogen (N_2). If the quantity of calcium hypochlorite injected is sufficient, a breakpoint is reached where all chloramines and ammonia are converted into nitrogen. The Figure 1.1 below presents the results of chlorination breakpoint laboratory testing for the Meliadine water.

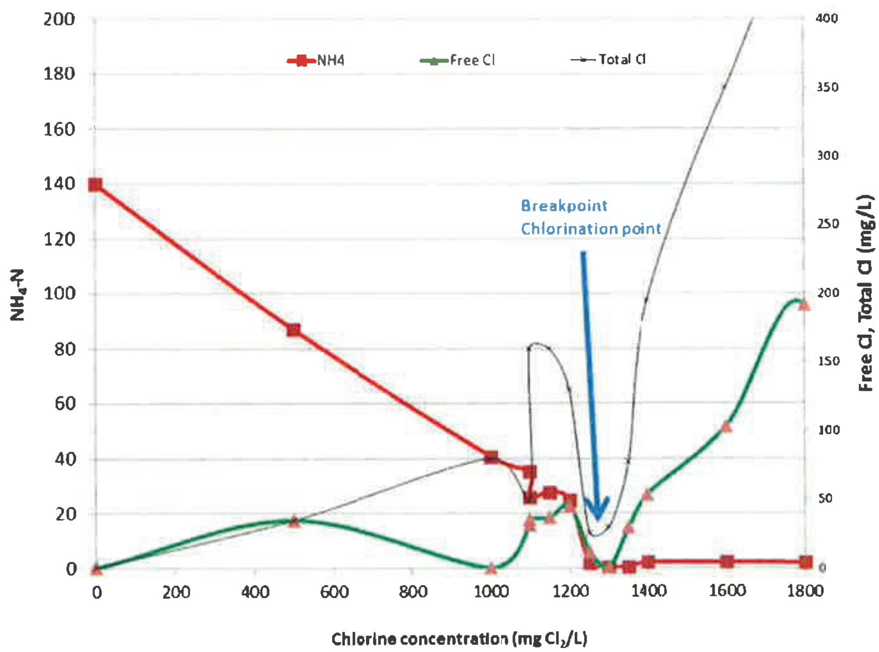


Figure 1: Breakpoint chlorination determination for Meliadine mine water (no dilution)

It is important to notice that once the breakpoint is passed, ammonia concentration is still low but free and combined chlorine are climbing up again. Accurate management of ammonia but also chlorine residual out of the chlorination tank is required to not exhaust the downstream Granular Activated Carbon (GAC), see Section 1.2.3.

1.2.3 GAC Filter

The water will then be pumped to Pressure Filters filled with Granulated Activated Carbon (GAC).The water is forced to pass through three bag filters in series with decreased mesh size from 50 to 5 microns for TSS removal and then the GAC filters, as a result of the pressure from the pump, and be exposed to the GAC for a period of the time. The residual chlorine and any chlorine by-products will be removed with the GAC filters. The treated water is then monitored for total chlorine, ammonia, pH, and turbidity. The GAC Filter backwash will be fully manual and operator has to validate the level in backwash tank prior to initiate a backwash. Exhaustion of GAC filter due to oxidation by chlorine and organic matter adsorption has to be carefully managed to improve lifetime of the GAC.

1.3 List of related documents

This document is to be read in conjunction with the following documents:

- P&IDs (5000219003_PI0001 page 1 to 12)
- Equipment List
- Table of setpoint and alarms
- All GA drawings
- Control architecture

1.4 List of abbreviations

The following abbreviations are used in the text of this document.

HMI: Human/Machine Interface
PLC: Programmable Logic Controller
SCADA: Supervisory Control and Data Acquisition
VFD: Variable Frequency Drive
VWTC: Veolia Water Technologies Canada

1.5 List of Units

The following lists the parameters referred to in this document and the units they are measured in unless otherwise specified.

Concentration (in general): mg/L
Flowrate (main process): m^3/h
Flowrate (chemical dosing): LPH
Level in tank: %
pH: -
Pressure: PSIg
Temperature: ° C
Turbidity: NTU
TSS: mg/L

2 Overall Plant Control

In this section, only the automatic control sequences are described.

2.1 Overview

The process includes the following unit operations:

- One (1) Multiflo® clarifier and instrumentation
- One (1) chlorination tank, mixing and transfer pumps and instrumentation
- Three (3) Bag filters and instrumentation
- Two (2) granular activated carbon filters and instrumentation
- One (1) Backwash waste water tank, transfer pumps and instrumentation
- One (1) multiparameter analyzer and associated valves (skid 2261)
- One (1) Coagulant dosing skid including 2 pumps (skid 2231)
- One (1) Anionic Polymer Preparation (skid 501)
- One (1) Anionic polymer Dosing Skid including 2 pumps (skid 2311)
- One (1) alkali Dosing Skid including 2 pumps (skid 2241)
- One (1) hypochlorite dosing skids each equipped with two pumps (skids 2271)

The WTP will receive an influent flow rate up to 400 m3/d.

2.2 Plant overall control

The inlet water flowrate is controlled from a setpoint adjustable by the operator, using two (2) modes: Program or Local.

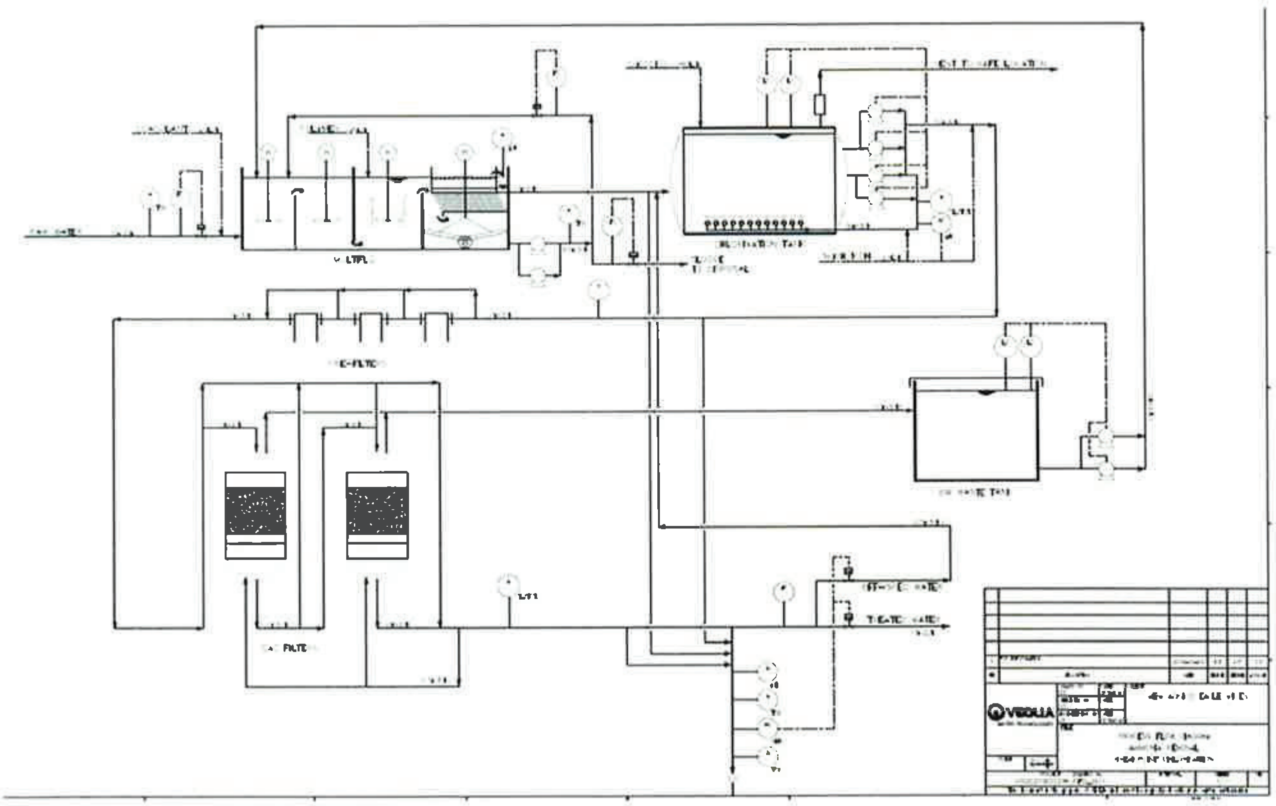
The water flows to the Multiflo, and Multiflo effluent flows by gravity to the chlorination tank. Transfer pumps pump chlorination tank effluent to GAC filters to maintain a level in the chlorination tank.

Depending on the treated water analyses, the final water will be directed in the treated water line or diverted in the off-spec water line.

Sludge produced by Multiflo is either recirculated or extracted to the sludge discharge line depending on a timer with feedback on TSS concentration in the sludge.

Backwash water from GAC filter is collected into a backwash tank and evacuated gradually using backwash pumps back to the Multiflo coagulation tank.

Chemicals are dosed proportionally to flow with correction factors to take into account pH or ammonia values for final effluent quality adjustment and oxidation efficiency.



3 MULTIFLO clarifier

3.1 Description

The inlet water enters the Multiflo unit with addition of coagulant prior to enter the Multiflo coagulation tank.

The clarified water is collected by troughs and enters the chlorination tank by gravity. The sludge produced by Multiflo® unit is directed to the sludge discharge line.

The detailed Multiflo® process functional description is presented in Appendix A.

The Multiflo® unit consists of the following control devices and instruments:

Table 3-1: Multiflo® control devices

SKID	P&ID TAG	DESCRIPTION	COMMENTS
	AIT0102	Inlet turbidity meter	
	FIT0101	Inlet flowmeter	
	FCV0101	Inlet valve	
	65AGI68001	Coagulation mixer	
	65AGI68002	Injection mixer	
	65AGI68003	Maturation mixer	VFD
	65TRM68001	Scraper	
	LSHH0116	High level switch	
	AIT0119	Turbidity meter effluent	
	AIT0126	TSS meter sludge	
	OSH0117	High Torque	
	65PSR68001A	Sludge pump #1	
	65PSR68001B	Sludge pump #2	

FIT0128	Sludge flowmeter to discharge line
FIT0127	Sludge flowmeter recirculation line
FCV0127	Valve to recirculation line
FV0129	Valve to discharge line

3.2 Controls

3.2.1 Multiflo flowrate setpoint

The inlet water flowrate is controlled from a setpoint adjustable by the operator. Two (2) modes are available:

In Local mode, operator will manually enter the desired water flowrate on the PID loop pop-up page.

In program mode, the flowrate setpoint is given by an outside source (TBC).

The Multiflo® unit flow is limited by minimum and maximum setpoints set by the operator at the interface.

Refer to project table of setpoint and alarms for setpoint values.

The inlet valve FCV0101 is a modulating valve. A PID loop controls the valve opening accordingly, using the flowrate from FIT0101 as a process value and the valve opening as setpoints.

3.2.2 Multiflo® Start/Stop/Auto function

By activating the Auto function, the Multiflo® is set in Auto start mode and is ready to start. If all start sequence conditions are satisfied, it starts only after receiving the automatic start command.

By deactivating the Auto mode, the Multiflo® stops following the automatic stopping sequence and a start and a stop button will be displayed on the HMI.

- by activating the Start function, the Multiflo® starts following the automatic starting sequence whatever the automatic start command status.
- by activating the Stop function on the HMI, the Multiflo® stops following the automatic stopping sequence.

If required equipment is in manual and not running when the Multiflo® Auto function is triggered, starting sequence cannot be activated.

3.2.3 Sludge pumps duty/stand-by mode

The extraction of sludge from the bottom of the settling tank is performed using sludge pumps.

Sludge pumps can be set with priority. The two pumps operate in a Duty/Stand-by configuration. If all pumps units are in "auto" but not running, the pump set as priority (duty) will start when the start conditions are met.

The pump priority (duty/Stand-by) is changed manually by the operator. The priority is changed automatically when the plant stops.

3.2.4 Sludge recirculation/extraction control

The sludge is mainly recirculated in the Multiflo, but to avoid sludge build-up, sludge can be extracted to the sludge discharge line to disposal. The extraction pumps are peristaltic pumps.

The operator enters a setpoint for the sludge extraction flowrate. A position setpoint is set for the sludge recirculation flowrate.

The recirculation line valve FCV0127 is a modulating valve. Its position setpoint is set in order to maintain a certain pressure.

The sludge extraction valve FV0129 is a modulating valve. A PID loop controls the valve opening accordingly, using the flowrate from FIT0128 as a process value and the valve opening as setpoints.

The sludge extraction is controlled using an ON (sludge extraction and recirculation) Timer and OFF (Recirculation only) timer.

During ON timer, the valve FV0129 will open to allow sludge to be directed to the discharge line.

During OFF timer, the valve FCV0127 will open and FV0129 will close.

In order to better control sludge concentration, a TSS analyzer is installed on the sludge line, prior to discharge or recirculate the sludge back to the head of the process.

The minimum discharge TSS setpoint is entered by the operator at the interface.

During the ON phase timer, if the TSS value is above the TSS setpoint (including an adjustable hysteresis), the ON timer is extended until the TSS value is lower that the TSS setpoint for an adjustable delay.

During the OFF phase timer, if the TSS value is below the TSS setpoint (including an adjustable hysteresis), the OFF timer is extended until the TSS value is higher that the TSS setpoint for an adjustable delay.

If the TSS analyzer is in fault, an alarm is generated and the sludge valve FV0129 opens to prevent sludge build-up in the Multiflo process.

If the fault is not reset after an adjustable delay, the Multiflo is stopped according to automatic shutdown sequence.

3.3 Fault response

If a fault occurs on one sludge pump, the priority is changed and the second pump starts.

If the second pump is not available (fault or manual mode), the Multiflo is stopped according to emergency shutdown sequence.

If the sludge valve FV0129 falls in fault, an alarm is generated.

If the sludge valve FCV0127 falls in fault, an alarm is generated.

If the sludge flowmeter FIT0127 or FIT0128 are in out of range fault, an alarm is generated..

If the sludge flowmeter FIT 0127 is in deviation alarm and the valve FV0129 is closed, an alarm is generated, the duty pump is stopped and stand-by pump starts. If the alarm is still active after the pump swap, a major fault is generated and the Multiflo is stopped according to automatic shutdown sequence to prevent pump or line blockage.

If the sludge flowmeter FIT 0128 is in low low alarm and the valve FV0129 is open, but the FIT0127 value is above the low low alarm, an alarm is generated. If the fault is not reset after an adjustable delay, the Multiflo is stopped according to automatic shutdown sequence to prevent line blockage.

3.4 Interlocks.

The faults that prevent the Multiflo to start are as follows:

- Two extraction pumps are in fault
- The chlorination tank LIT0042 or LIT 0041 is in high high alarm
- The inlet valve FCV0101 is in fault
- The inlet flowmeter FIT0101 is in out of range fault
- Chlorination tank in major fault

Specific Multiflo interlocks are detailed in Multiflo FD in Appendix B.

4 Chlorination tank

4.1 Description

The effluent from the Multiflo unit flows with a free discharge to a chlorination tank so that the water level in the tank has no influence on the water level in the Multiflo.

The chlorination tank control is achieved by the following control devices and instruments:

Table 4-1: Chlorination tank devices

SKID	P&ID TAG	DESCRIPTION	COMMENTS
	LIT0241A/LIT0241B	TANK LEVEL TRANSMITTERS	
	PIT0263	PRESSURE TRANSMITTER	
	65PWA68001A/65PWA68001B	TRANSFER PUMPS #3 and 4	WITH VFD
	65PWA68002A/65PWA68002B	MIXING PUMPS #1 and 2	WITH VFD
	AIT0266	TOTAL CHLORINE ANALYZER	
	AIT0264	FREE CHLORINE ANALYZER	
	AIT0268A/AIT0268B	pH / TEMPERATURE ANALYZER	

4.2 Controls

4.2.1 Level control

The chlorination tank is equipped with two redundant level transmitters, LIT0241A and LIT0241B and two transfer pumps.

Level transmitters can be set with priority. The two level transmitters operate in a primary/secondary configuration

The level transmitter priority (primary/secondary) is changed manually by the operator. The priority is changed automatically when one transmitter is in out of range fault.

A deviation alarm will be generated if the differential between the two level transmitters is above an adjustable value.

The operator enters a level setpoint on the interface.

The transfer pumps are equipped with VFD. A loop controls the Pump VFD accordingly, using the level LIT-0241 (primary value) as a process value and the speed of the pumps as setpoints to maintain a constant level and optimize the contact reaction time.

If the level in this tank increases, the flow rate pumped from the tank should also increase. If the level in the tank is lower than the setpoint, the pump will slowly decrease speed until the setpoint level is reached.

When low level alarm in chlorination tank is activated, the transfer pumps are stopped. They are restarted once the high alarm is reached. These two alarms are auto-reset.

4.2.2 Chlorination tank transfer pumps' Logic

In normal operation, only one transfer pump needs to run. The operator selects the duty/standby pump on the interface.

When the duty pump is in fault or not running and the Multiflo® unit is in operation, the standby pump starts. If the second pump is in fault or in manual (not running) a message is displayed and the Multiflo® unit is stopped according to the automatic stop sequence.

Each time the running pump is stopped, the same pump starts at the next Multiflo® start sequence. If the pump is in manual or in fault, the second pump starts.

A button on the HMI permits to alternate manually the priority.

In case of the two transfer pump failure, the mixing pump 65PAW68001B (pump #2) can be used as a transfer pump.

The operator has to open the manual valve 80-BA99-0245 and close manual valve 80-BA99-0233, and confirm on the SCADA that the pump 65PAW68001B is the duty pump for transfer.

Once this operation has been completed, the plant can restart.

4.2.3 Mixing control

The chlorination tank is equipped with two mixing pumps.

In normal operation, two mixing pump need to run to provide mixing energy.

If the two pumps are not available, an alarm is generated and the Multiflo® unit is stopped according to the automatic stop sequence.

However, if only one pump is in fault or not running, or the pump #2 is assigned as a transfer pump, an alarm is generated but the other pump continues to run.

In case of the two mixing pump failure, the transfer pump 65PAW68002A (pump #3) can be used as a mixing pump.

The operator has to open the manual valve 80-BA99-0245 and close manual valve XXX18, and confirm on the SCADA that the pump 65PAW68002A is the duty pump for mixing.

Once this operation has been completed, the plant can be restarted.

4.3 Fault response

If a fault occurs on one mixing or transfer pump, the priority is changed and the second pump starts.

If the second pump is not available (fault or manual mode), the Multiflo is stopped according to automatic shutdown sequence. However, manual operation of valves and pumps duty transfer on the SCADA can allow a plant restart (see section 4.2.2 and 4.2.3)

If the primary level transmitter is in out of range fault, an alarm is generated and priority is automatically changed to the other level transmitter. If both transmitters are out of range, the chlorination tank is in major fault.

If High high or Low Low PIT0263 pressure transmitter alarms are activated, the transfer pumps are stopped.

4.4 Interlocks.

A low low level alarm in the chlorination tank prevents the transfer pumps and mixing pumps to start.

An out of range alarm on both level transmitters prevent the mixing and transfer pump to start.

5 Granular activated carbon filters

5.1 Description

Water is pumped from chlorination tank to a series of bag filters from 50 microns to 5 microns mesh to reduce TSS and then to granular activated carbon (GAC) pressure filters for dechlorination prior to effluent final discharge.

The GAC filters system is composed of the following control devices and instruments.

Table 5.1-1: GAC filter system control devices

SKID	P&ID TAG	DESCRIPTION	COMMENTS
	FIT0342	Flowmeter	
	AIT0341	Chlorine analyzer	
	FV0343	Treated water valve	Open/close detector
	FV0344	Off-spec valve	Open/close detector

5.2 Controls

5.2.1 Valves control

In order to discharge effluent within effluent criteria, chlorine analyzer as well as ammonia, TSS and pH analyzer (multi-parameter analyzer, see section 7) are installed on the GAC filter effluent line, prior to discharge to treated water line or off-spec water line.

The allowed discharge effluent setpoints (TSS_{max}, $ammonia_{max}$, pH_{min}, pH_{max}, $Chlorine_{max}$) is entered by the operator at the interface.

When the transfer pump from chlorination tank starts, the valve FV0343 (treated water valve) opens.

During the initial start-up of the plant, alarms are disabled for an adjustable period to enable enough time for complete on-line water analysis. After this adjustable delay, if all the effluent values are lower that the setpoints (including an adjustable hysteresis to prevent frequent opening and closing of the valve) for an adjustable delay, the valve FV0343 stays open.

When at least one of the values is above the corresponding setpoint (or below for pH_{min}) for an adjustable delay, the valve FV0344 will open to allow water to be directed back to the chlorination tank through to the off-spec line and valve FV0343 will close once the opening status of the FV0344 is confirmed.

The Multiflo will be stopped using the normal stopping sequence to prevent more water to enter the off-spec water loop. The chemical dosages will be adapted depending on the source of the non-compliance. The description of this off-spec mode is described in the respective sections 11.2.2 and 12.2.2.

When all of the values are below the corresponding setpoint (or above pH_{min}) for an adjustable delay, the valve FV0343 will open to allow water to be directed to the treated water line line and valve FV0344 will close once the opening status of the FV0343 is confirmed.

The Multiflo will then restart in automatic to provide water to the chlorination tank.

5.3 Fault response

The following faults will stop the chlorination tank transfer pumps:

1. opening/closing fault from FV0343 (treated water valve)

If one of the analyzer (pH, TSS, chlorine, ammonia) is in fault, an alarm is generated and the off-spec valve FV0344 opens and treated water valve FV0343 closes to prevent off-spec water to be discharged to the treated water line.

5.4 Interlock

No interlock.

6 Backwash waste water tank

6.1 Description

The backwash tank collects water from manual GAC filter backwashes. This tank should remain empty most of the time to allow the operator to backwash the GAC filter as needed.

The backwash tank is made up of the following control devices and instruments:

Table 6.1: Backwash tank control devices

SKID	P&ID TAG	DESCRIPTION	COMMENTS
	LIT0326A/LIT0326B	Level transmitters	
	65PSR680002A	Backwash tank pump #1	
	65PSR680002B	Backwash tank pump #2	

6.2 Controls

6.2.1 Level control

The backwash tank is equipped with two redundant level transmitters, LIT0326A and LIT0326B and two transfer pumps.

Level transmitters can be set with priority. The two level transmitters operate in a duty/standby configuration

The level transmitter priority (lead /lag) is changed manually by the operator. The priority is changed automatically when one transmitter is in out of range fault.

The transfer pumps are equipped with VFD. A loop controls the Pump VFD accordingly, using the lead level transmitter as a process value and the speed of the pumps as setpoints.

If the level in this tank increases, the flow rate pumped from the tank should also increase. If the level in the tank is lower, the pump will slowly decrease speed until stop level is reached.

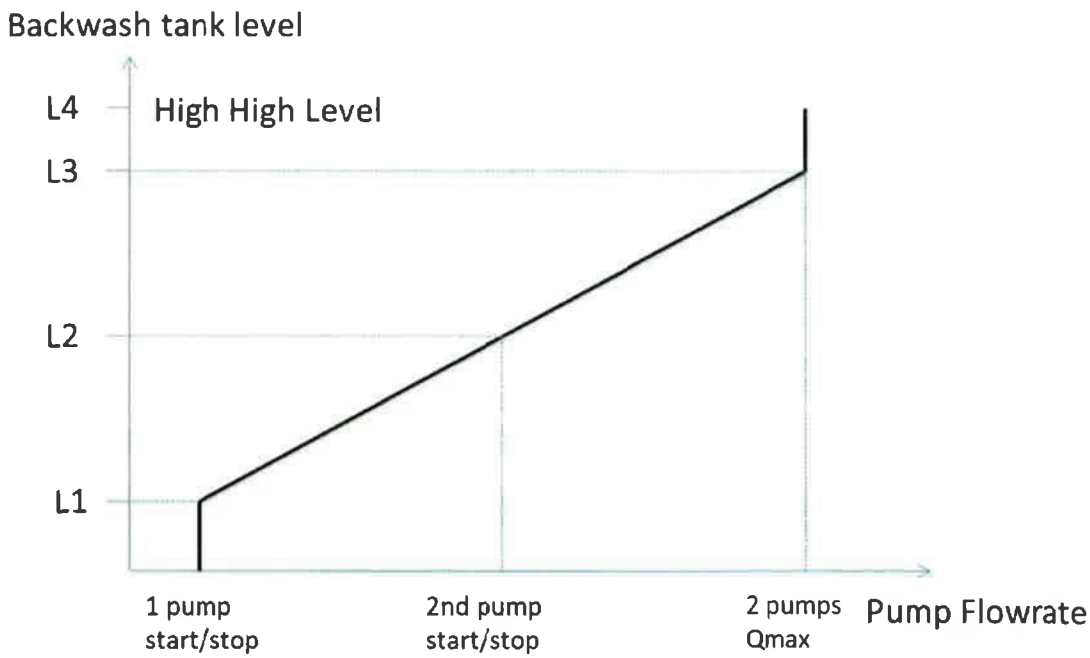


Figure 6-1 backwash tank level control

The following three (3) set points must be entered by the operator to properly control the flow and number of operating pumps.

Duty pump start level (LT_SP1);
Assist pump start level (LT_SP2);
Maximum speed pumps (LT_SP3);

When two pumps are operated at the same time, the pumps VFD setpoints are equal.

6.2.2 Backwash tank transfer pumps' Logic

In normal operation, only one transfer pump needs to run. The operator selects the assist pump on the interface.

When the duty pump is in fault or not running and the Multiflo® unit is in operation, the assist pump starts. If the assist pump is in fault or in manual (not running) an alarm is generated and a message is displayed to warn the operator

Each time the running pump is stopped, the other pump starts at the next start sequence. If the pump is in manual or in fault, the second pump starts.

A button on the HMI permits to alternate manually the priority.

6.3 Fault Response

When the duty pump is in fault or not running and the Multiflo® unit is in operation, the assist pump starts. If the second pump is in fault or in manual (not running) an alarm is generated and a message is displayed to warn the operator.

If low low level alarm on duty LIT0326 is activated, transfer pump is stopped until operator is able to reset the alarm.

If the two transmitters readings have discrepancy higher than an adjustable deviation value, an alarm is generated.

If the duty level transmitter is out of range, the priority is automatically transferred to the stand-by level transmitter. If both level transmitters are out of range, an alarm is generated and message is displayed to warn the operator about risk of overflow during GAC backwash. The backwash pumps and chlorination tank transfer pumps are stopped.

6.4 Interlock

The interlocks that prevent the backwash tank pumps to start are:

- Low low level in backwash tank from duty level transmitter
- Both level transmitters out of range
- Multiflo not running

7 Sampling and analyses units

7.1 Description

A multiparameter analyzer allows the different streams to be analyzed in sequence. Different on-line analyzers located at the processes give multiple information to control the process and chemical dosing.

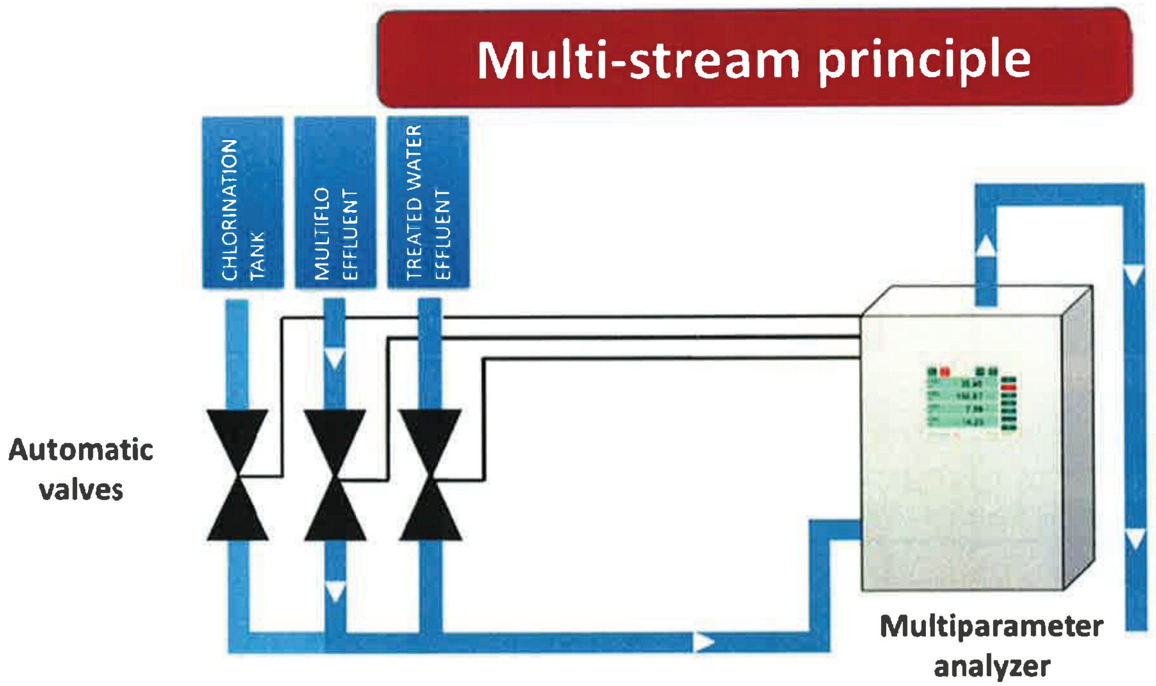
The multiparameter analyzer unit and on-line analyzers consists of the following control devices and instruments as follows:

Table 7.1: hypochlorite dosing system control devices

SKID	P&ID TAG	DESCRIPTION	COMMENTS
	AIT0371	TREATED WATER TSS ANALYZER	
	AIT0361	TREATED WATER pH	
	AIT0362	MULTIFLO EFFLUENT pH	
	AIT0370A/0370B/0370C	TOC ANALYZER	
	AIT0372A/0372B/0372C	AMMONIA ANALYZER	
	FV0356	MULTIFLO EFFLUENT ON/OFF VALVE	
	FV0357	TREATED WATER ON/OFF VALVE	
	FV0358	CHLORINATION TANK ON/OFF VALVE	
	FV0351	DILUTION WATER VALVE	

7.2 Controls

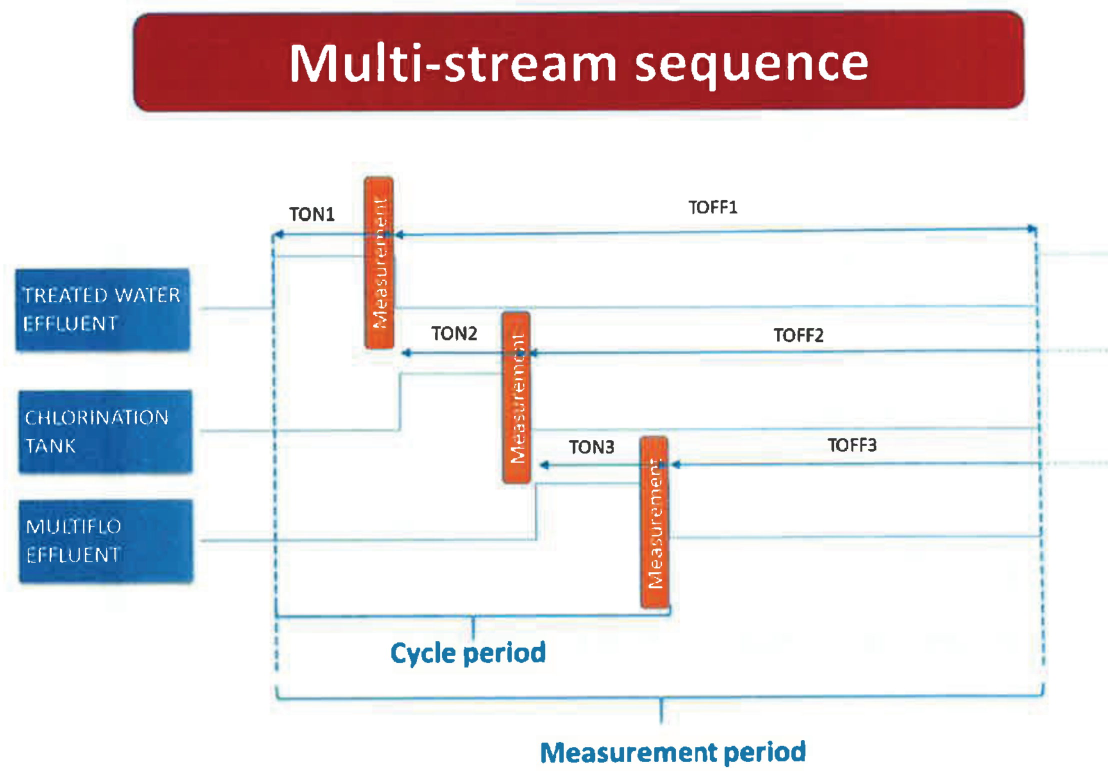
Automatic ON/OFF valve will alternate in sequence to deliver three different streams to the multiparameter analyzer.



The valve FV0357 will open to allow treated effluent stream to the multiparameter instrument for an adjustable timer (T_{ON1}). When T_{ON1} is elapsed, valve FV0357 will remain closed during an OFF timer (T_{OFF1}).

The valve FV0358 will open to allow chlorination tank stream to the multiparameter instrument for an adjustable timer (T_{ON2}). When T_{ON2} is elapsed, valve FV0358 will remain closed during an OFF timer (T_{OFF2}).

The valve FV0356 will open to allow Multiflo effluent stream to the multiparameter instrument for an adjustable timer (T_{ON3}). When T_{ON3} is elapsed, valve FV0356 will remain closed during an OFF timer (T_{OFF3}).



The valves are controlled via the multiparameter instrument relays.

7.3 Fault Response

If the valves are in fault, an alarm is generated and the other valves cannot be operated until the alarm is reset.

If the analyzers are out of range, an alarm is generated.

7.4 Interlock

The valves FV-0356, FV0357 and FV0358 cannot be open at the same time.
If a valve receives the opening signal, it must wait until the other valves are closed.
The FV0356 and FV0358 valves do not operate if the low low alarm is activated on FIT0101 or if the plant is stopped.
The FV0357 do not operate if the low low alarm is activated on FIT0342.
If one valve is in fault, the other cannot operate to avoid contamination of the lines.

8 Coagulant Dosing pumps

8.1 Description

Coagulant is dosed proportionally to the Multiflo® unit's raw water flow rate indicated by FIT0101. It is pumped with 65PME68001A or 65PME68001B from the coagulant Dosage tank 65TNK68007 towards the Inlet of the Multiflo.

The coagulant dosing unit consists of the following control devices and instruments completely pre-piped and arranged on a skid as follows:

Table 8.1: Coagulant dosing system control devices

SKID	P&ID TAG	DESCRIPTION	COMMENTS
2231	LSLL0411/LSLL0421	COAGULANT TANK LOW LEVEL SWITCHS	INTEGRATED WITH PUMPS
2231	65PME68001A	DOSING PUMP 1 - COAGULANT DOSING	WITH VFD
2231	65PME68001B	DOSING PUMP 2 - COAGULANT DOSING	WITH VFD

8.2 Controls

The detailed coagulant pump functional description including fault response and interlocks is presented in Appendix C.

9 Polymer Make-up System

9.1 Process Overview, description

The **Hydrapol 500** is an automatic machine for batch preparation of polymer solutions. A screw doses dry polymer powder into a cone, and then service water wets it in a water whirl. The mixture is discharged into a maturation tank where a mixer agitates the solution during a period of 60 -90 minutes. After this period the solution is transferred into a storage tank.

The automatic polymer preparation system consists of the following control devices and instruments completely pre-piped and arranged as follow:

Table 9-1: Polymer preparation system control devices

SKID	P&ID TAG	DESCRIPTION	COMMENTS
501	ND62-03	DRY POLYMER VACUUM – POLYMER PREPARATION	
501	ND62-01	FEEDER SCREW MOTOR	
501	PSLL62-01	PRESSURE SWITCH - POLYMER PREPARATION	
501	LSL0232	LOW LEVEL SWITCH – POLYMER PREPARATION	
501	VE62-02	4-WAY SOLENOID VALVE – POLYMER PREPARATION	
501	VE62-01	SOLENOID VALVE - POLYMER PREPARATION	
501	VA62-01	TRANSFER VALVE - POLYMER PREPARATION	
501	LT62-01	LEVEL TRANSMITTER - POLYMER MATURATION TANK	
501	AG62-01	MIXING TANK AGITATOR	
501	LT62-02	LEVEL TRANSMITTER - POLYMER STORAGE TANK	

9.2 Controls

The detailed polymer make-up system functional description can be found in Appendix D, including fault response and interlocks.

10 POLYMER DOSING SYSTEM

10.1 Process Overview

The polymer is metered proportional to the raw water flow FIT0101. It is pumped with 65PME68002A or 65PME68002B from the polymer storage tank TL62-02 towards the flocculation tank of the Multiflo.

The polymer dosing unit consists of the following control devices and instruments completely pre-piped and arranged on a skid as follow:

Table 10.1-: Polymer dosing system control devices

SKID	P&ID TAG	DESCRIPTION	COMMENTS
2311	FV0466	ON/OFF VALVES - CARRIER WATER MULTIFLO	
2311	65PME68002A	POLYMER DOSING PUMP #1 - MULTIFLO	WITH VFD
2311	65PME68002B	POLYMER DOSING PUMP #2 -BACKUP	WITH VFD
2311	TSH0451	POLYMER DOSING PUMP #1 – TEMPERATURE SWITCH	
2311	TSH0461	POLYMER DOSING PUMP #2 – TEMPERATURE SWITCH	

10.2 Controls

The detailed polymer dosing system functional description can be found in Appendix E, including fault response and interlocks.

11 Alkali Dosing pumps

11.1 Description

Alkali (mixture of KOH and NaOH) is dosed in the chlorination tank to maintain the optimal pH for ammonia oxidation. It is pumped with 65PME68003A or 65PME68003B from the alkali Dosage tank 65TNK68008 towards the mixing line of the chlorination tank.

The alkali dosing unit consists of the following control devices and instruments completely pre-piped and arranged on a skid as follows:

Table 11.1: Alkali dosing system control devices

SKID	P&ID TAG	DESCRIPTION	COMMENTS
2241	LSLL0511/LSLL0521	ALKALI TANK LOW LEVEL SWITCH	INTEGRATED WITH PUMP
2241	65PME68003A	DOSING PUMP 1 - ALKALI DOSING	WITH VFD
2241	65PME68003B	DOSING PUMP 2 - ALKALI DOSING	WITH VFD

11.2 Controls

11.2.1 pH control when Multiflo is in operation

The alkali is dosed proportionally to the calculated flowrate as described in the specific alkali functional description (Appendix F), but the dosage is modulated to maintain a pH at an adjustable setpoint entered by the operator on the interface.

A PID loop controls dosing setpoint accordingly, using the pH meter AIT0268A as a process value and the dosing setpoint as setpoints to maintain a constant pH.

If the pH value as read by the pH meter AIT0268A is below the pH setpoint, the dosing setpoint is incremented.

If the pH value as read by the pH meter AIT0268A is above the pH setpoint, the dosing setpoint is decreased.

The changes are capped by an adjustable range to prevent overdose or underdose of alkali.

If the pH meter is out of range, the PID loop is deactivated and only dosing setpoint is taken into account.

A button on the interface also allows the operator to select the pH control or disable it (in case of pH sensor malfunction).

11.2.2 pH control in off-spec loop

If the final water does not meet treated water requirements, water is recirculated in loop in the chlorination tank and Multiflo is stopped.

If pH in treated water is above the treated water requirement, the alkali dosage is stopped. The alkali dosing pump will only restart when Multiflo will be started again.

If pH is above the treated water requirement, then the speed of the dosing pump will be only controlled by pH meter.

A PID loop controls dosing setpoint accordingly, using the pH meter AIT0268A as a process value and the dosing setpoint as setpoints to maintain a constant pH. This loop is maintained as long as the Multiflo is not started again.

11.2.3 Functional description, fault response and interlocks

The detailed alkali pump functional description including fault response and interlocks is presented in Appendix F.

12 Calcium hypochlorite Dosing pumps

12.1 Description

Calcium hypochlorite is dosed in the chlorination tank to oxydize ammonia and nitrites into nitrogen gas (N_2). It is pumped with 65PME68004A or 65PME68004B from the hypochlorite storage tank 65TNK68005 towards the chlorination tank.

The hypochlorite dosing unit consists of the following control devices and instruments completely pre-piped and arranged on a skid as follows:

Table 12.1-1: hypochlorite dosing system control devices

SKID	P&ID TAG	DESCRIPTION	COMMENTS
2271	65PME68004A	DOSING PUMP 1 - HYPOCHLORITE DOSING	WITH VFD
2271	65PME68004B	DOSING PUMP 2 - HYPOCHLORITE DOSING	WITH VFD

12.2 Controls

12.2.1 Ammonia and chlorine residual control when Multiflo is in operation

The calcium hypochlorite is dosed proportionally to the calculated flowrate as described in the specific hypochlorite functional description (Appendix G) and the inlet ammonia and TOC concentration given by AIT0372 and AIT0370, but the dosage is modulated to maintain an ammonia concentration at an adjustable setpoint entered by the operator on the interface.

The operator has three options for the hypochlorite dosing:

Option 1: Dosage entry

The operator enters a required hypochlorite dosage RC_{HYPO} in mg/L or μL/L on the interface. The calculations for pump speed are presented in Appendix G.

Option 2: Stoichiometric dosage

The required dosage concentration RC_{HYPO} when expressed in mg/L is calculated as follows:

RC_{HYPO}= 7.6 x [NH4 inf] + Correction factor 1

Where NH4inf is the ammonia concentration in mg/L as given by ammonia analyzer AIT0372A when reading Multiflo effluent.

The correction factor 1 can be modulated by the operator to control the free chlorine residual and is capped to avoid underdosing or overdosing of calcium hypochlorite.

Option 3: Stoichiometric dosage with effluent correction

A feed forward volumetric loop is used to modulate the calculated required concentration.

The required dosage concentration RC_{HYPO} when expressed in mg/L is calculated as follows:

RC_{HYPO}= 7.6 x [NH4 inf] + Correction Factor 2

Where NH4inf is the ammonia concentration in mg/L as given by ammonia analyzer AIT0372A when reading Multiflo effluent).

A volumetric PID loop controls dosing setpoint accordingly, using the ammonia meter AIT0372B (when reading chlorination tank effluent) as a process value and the ammonia effluent setpoint as setpoint to maintain a constant effluent ammonia value.

If the ammonia effluent value as read by the NH4 meter AIT0372B is above the NH4 setpoint, the dosing setpoint is increased.

If the ammonia effluent value as read by the NH4 meter AIT0372B is below the NH4 setpoint, the dosing setpoint is decreased.

The Factor is clamped by an adjustable range to prevent overdosing or underdosing of hypochlorite.

If the NH4 meter is out of range, the PID loop is deactivated and only dosing setpoint (option 1) is taken into account.

A button on the interface allows the operator to select the NH4 control option.

12.2.2 Ammonia and chlorine residual control in off-spec loop

If the final water does not meet treated water requirements, water is recirculated in loop in the chlorination tank and Multiflo is stopped.

If NH4 and Chlorine concentration in treated water are below the treated water requirement, the dosage is stopped. The calcium hypochlorite dosing pump will only restart when Multiflo will be started again.

If NH4 is below the treated water requirement but chlorine is above the treated water requirement, the dosage is stopped. The calcium hypochlorite dosing pump will only restart when Multiflo will be started again.

If NH4 is above the treated water requirement, then the required dosage is calculated as follows:

RC_{HYPO}= 7.6 x [NH4 chlorination tank] and Q_{IN2} is based on FIT0342 instead of [FIT0101-FIT0128].

12.2.3 Functional description, fault response and interlocks

The detailed calcium hypochlorite pump functional description including fault response and interlocks is presented in Appendix G.

13 Summary of Interlocks that trigger WTP trip

- RAW WATER FLOWMETER OUT OF RANGE
- RAW WATER FLOWMETER LOW LOW FLOWRATE
- HIGH HIGH MULTIFLO TURBIDITY
- MULTIFLO HIGH HIGH LEVEL
- HIGH HIGH MULTIFLO SCRAPER TORQUE
- MULTIFLO AGITATOR FAULT
- MULTIFLO SCRAPER FAULT
- MULTIFLO BOTH SLUDGE PUMPS FAULT
- CHLORINATION TANK HIGH HIGH LEVEL
- BOTH CHLORINATION TANK LEVEL METERS IN FAULT
  CHLORINATION MIXING PUMPS NOT READY /FAULT
- CHLORINATION TRANSFER PUMPS NOT READY /FAULT
- GAC EFFLUENT FLOWMETER OUT OF RANGE
- GAC EFFLUENT LOW LOW FLOW FLOWRATE
- BOTH COAGULANT DOSING PUMPS IN FAULT
- POLYMER PREPARATION SYSTEM LOW LEVEL DOSAGE TANK
- BOTH POLYMER DOSING PUMPS IN FAULT
- BOTH HYPOCHLORITE PUMPS IN FAULT
- BOTH KOH/NAOH PUMPS IN FAULT

14 Trends

14.1 Graphic pages

The Contractor must provide the graphic pages necessary for the proper operation of the system. The following list is not exhaustive and should correspond to the requirements of the plans and specifications:

1. One page on the entire operation of the treatment station and one page for each P & ID page;
2. Real time data;
3. Alarms graphic page;
4. Graphical page of trend curves (flow, on-line analyzers);
5. Graphical equipment calibration page.

14.2 Display and indications

• State:

1. State of the breakpoint chlorination treatment plant;
2. Operating condition of each pump or motorized equipment;
3. Indication of flow rates;
4. Indication of all analytical values (pH, NH4, Chlorine, TSS, turbidity)
5. Operating status of chemical dosing systems
6. Operating pressure of operating systems;
7. Measurement of tanks levels;
8. Operation of VFDs;
9. Equipment running time.

14.3 Faults and alarms

Failure of motorized equipment and instruments;

Alarms according to the table of setpoints, parameters and alarms.

14.4 Compiled data

1. Measurement and compilation of all flows;
2. Cumulative run times of each pump and equipment;
3. Number of departures per day for the last five days for each pump;
4. Daily, weekly, monthly and annual average of influent flow, sludge discharge flow, off-spec flow and treated water flow.

14.5 Trends

1. Trends can be analog points or the internal result.
2. Trend curves will be recorded on a 30-day possibility.

14.6 Alarm management

1. Alarm management is required to inform the operator of the status of the water treatment system. All alarms will be compiled into a register for later reference.
2. The alarms will be transmitted to the operator via a communication system integrated into the supervision software.
3. The combined alarm will operate a strobe light/horn outside the building (TBC).

APPENDIX A

Set point table

APPENDIX B

Multiflo clarifier

Functional Description

Multiflo®

PROCESS CONTROL DESCRIPTION

VEOLIA WATER TECHNOLOGIES CANADA
www.veoliawatertechnologies.com

REVISION STATUS

Issue	Date	Created	Reviewed	Approved	Description of Changes
1	2019/02/28	MD	GP		First Issue

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1 INTRODUCTION

1.1 Reference Documents

Document Number	Name	Revision
5000219003_PI_0001_GEN_VWT	PI001 _Process and Instrumentation diagram	1

1.2 Process Overview

The Multiflo™ is a compact clarification system using flocculation reactor and enhanced lamella settling. The raw water will enter the first tank section called coagulation tank, where a coagulant is injected. The aluminum based coagulant forms a floc of aluminum hydroxide ($Al(OH)_3$) which acts as a bridge to tie colloidal particles together. The coagulated water then enters the flocculation tank, where an anionic polymer is added. The polymer binds the suspended solids by forming polymer bridges and the flocs agglomerate and grow into high-density flocs. From the flocculation zone, the water overflows to the settling section of the tank. In the settling zone, the high-density flocs settle quickly to the bottom of the unit. In the settling zone, the efficiency of settling is further increased by the use of the lamella tubes. The sludge is collected at the bottom of the settling tank, under the lamella tubes. The sludge produced will be pumped to the sludge discharge line, while the effluent exits the water via a weir.

1.3 List of Abbreviations

The following abbreviations are used in the text of this document.

- HMI: Human/Machine Interface
- H-O-A: Hand-Off-Auto
- PLC: Programmable Logic Controller
- LCP: Local Control Panel
- VFD: Variable Frequency Drive
- VWT: Veolia Water Technologies Canada

1.4 List of Units

The following lists the parameters referred to in this document and the units they are measured in unless otherwise specified.

- Concentration (in general): mg/L
- Dosing rate: mL/L
- Flow rate (main process): m^3/h
- Flow rate (chemical dosing): LPH
- Level in the tanks: %
- pH: -
- Pressure: PSIg
- Temperature: °C
- Turbidity: mg/L or NTU

2 MULTIFLO® CONTROL DESCRIPTION

2.1 Equipment and Instrument

This section connects the tags from the P&ID and the terminology used throughout Equipment and Instrument Schedules.

Project Tag No	Standard Tag-No.	Description
AIT0102	AIT11-01	Inlet turbidity meter
FIT0101	FIT11-01	Inlet flowmeter
FCV0101	VC11-01	Inlet valve
65AGI68001	AG20-01	Coagulation mixer
65AGI68002	AG20-02	Injection mixer
65AGI68003	AG20-03	Maturation mixer
65TRM68001	RC20-03	Scraper
LSHH0116	LSH20-01	High level switch
AIT0119	AIT20-01	Turbidity meter effluent
AIT0126	AIT20-02	TSS meter sludge
OSH0117	SSL20-03	High Torque
65PSR68001A	PC30-01	Sludge pump #1
65PSR68001B	PC32-01	Sludge pump #2
FIT0128	FIT11-02	Sludge flowmeter to discharge line
FIT0127	FIT11-03	Sludge flowmeter recirculation line
FV0129	VC11-02	Valve to discharge line
FCV0127	VC11-03	Valve to recirculation line

2.2 Operating Modes Overview

There are two primary modes for each MULTIFLO®: Manual and Semi-Automatic. The Manual mode is designed for operation of individual equipment. The Semi-Auto mode is designed for operation of the MULTIFLO® system as a whole.

Local mode

In local Mode, the operator can operate individual equipment.

Equipment can be started manually at the LCP using the Hand position of the H-O-A.

HMI manual mode

The operator can operate individual equipment though HMI control if the Local switch on that equipment is in the Auto position. Manual operation from the HMI provides the same equipment protection and alarming as Semi-Auto.

Semi-Auto

Semi-Auto mode allows the operator to initiate the MULTIFLO® system start-up and shutdown sequences from HMI or remotely.

NOTE: Train equipment cannot be controlled manually while in Semi-Auto operation.

The coagulation mixer or injection mixer, maturation mixer, scraper, and at least one sludge pump H-O-As must be in Auto to enable Semi-Automatic control of all respective equipment at the HMI and at the LCP. All startup sequences are described below. Each MULTIFLO® train and its associated equipment are controlled as an independent system by the PLC.

The table below presents the control modes summary.

Table 1: Summary of Control Modes

	Manual		**Semi-Auto**
	Local	**HMI Manual**	
Control Functions	N/A	N/A	Allowed (PLC)
Initiation of Semi-Automatic functions	N/A	N/A	Operator or Remote Start-up Initiation Required
HMI Operation of Individual Equipment	N/A	Allowed (virtual HOA on HMI)	Not Allowed
Local Operation of Individual Equipment	Allowed By HOA on LCP	N/A	Not Allowed

2.3 PERMISSIVE

Permissive to allow initiation of the Semi-Automatic start sequence are:

- H-O-A selector switches for mixers, scraper and at least one sludge pump, are in Auto at the HMI and at the LCP.
- Mixers (whichever is in Auto at HMI and LCP), scraper, and the above mentioned sludge pump do not have existing equipment alarms.
- Aforementioned equipment alarms must be manually reset.

2.4 OPTIONS

Idle option

When the idle option is enabled, the Multiflo keeps the inlet valve open all the time.

2.5 Semi-Auto Train Response To Equipment Conditions

2.5.1 Equipment Removed From Auto PLC Response

If the mixers and the scraper are removed from Auto at the LCP while the PLC is running in Semi-Automatic control of the MULTIFLO® system, the PLC will initiate a Shutdown Sequence as described in section 2.7.2.

Since the scraper will not be operational, the Shutdown Sequence will consist of the sludge pumps running for the durations indicated in section 2.7.2.

If the lead sludge pump is removed from Auto at the LCP, the PLC will sequentially initiate operation of the next available pump. If all sludge pumps are removed from Auto or no additional pumps are available, the PLC will initiate an emergency shutdown of all equipment.

NOTE: No alarm will be generated if an MULTIFLO® system shutdown is initiated due to a piece of equipment being removed from Auto by the operator.

2.5.2 Equipment Failure PLC Response

If the coagulation mixer fails during Semi-Automatic control of the MULTIFLO® system, the system will continue to run.

Should the injection mixer or the maturation mixer fail at any time during Semi-Automatic control of the MULTIFLO® system, the PLC will issue an equipment alarm and will initiate a Shutdown Sequence as described in section 2.7.2.

Should the scraper fail at any time during operation or start-up, the PLC will issue an equipment alarm and will initiate a Shutdown Sequence as described in section 2.7.2. Since the scraper will not be operational, the Shutdown Sequence will consist of the sludge pumps running for the durations indicated in section 2.7.2.

Should lead sludge pump fail, the PLC will issue an equipment alarm and sequentially initiate operation of the next available pump. If all sludge pumps fail or no additional pumps are available, the PLC will initiate an emergency shutdown of all equipment.

NOTE: An AVAILABLE sludge pump is defined as one that is placed in Auto at the LCP and does not have any existing un-reset alarm conditions.

2.6 Recirculation Pumps Logic

2.6.1 Duty/Assist Orientation

When two sludge lines are provided they can be set with priority. The two sludge pumps operate in a Duty / Assist orientation. If all sludge pumps are in "auto" but not running, the pump set as priority (duty) will start when the start condition will be met. If the influent quality deteriorates, as indicated by an increase in raw water turbidity, the operator can use the second sludge line by starting the second pump from the HMI.

The sludge pumps priority (duty or assist) is changed manually by the operator anytime or is changed automatically when the plant stops.

2.7 Sequences Of Functions

2.7.1 Start-up Sequence

If all permissive conditions are present and no respective equipment alarms exist, the HMI will display **"Train Ready"**. The Start-up Sequence can now be initiated via the HMI or remotely.

NOTE: To prevent damage to the equipment, the Train must have water in the tanks above the mixer impeller elevations prior to Start-up (to be checked by the operator).

To start the train when "Train Ready" is displayed on the HMI, the operator presses the "Train Start" pushbutton. A starting system displays "Train Starting" at the HMI. The start-up sequence automatically cycles through the steps listed below.

1. System Start-up Initiated:
   a. **Start the Duty Sludge Pump**

If a failure occurs, the duty pump will be locked out in the PLC and the next available pump will be assigned as the lead pump. The PLC will then attempt to continue operation. This cycle will occur until a sludge pump starts or all sludge pumps have been locked out. If all sludge pumps are locked out, the PLC will immediately abort the start-up.

2. Delay 30 seconds (adjustable):
   a. **Start the Scraper**

If a Scraper failure occurs initiate a Shutdown Sequence.

3. Delay 10 seconds (adjustable):
   a. **Start the mixers**. These mixers start are respectively staggered by 5 seconds.

If a maturation Mixer failure occurs initiate a Shutdown Sequence.

4. Delay 10 seconds (adjustable):
   a. **Start the Chemical Feed Pumps**
   b. **Open Raw water Valve. Open Water Polymer Carrier Solenoid valve**
   c. HMI will display **"Train Started"**

The Operator can terminate the start-up at any point in the sequence by pressing the "Train Stop" pushbutton. If any pertinent equipment fails during the start-up sequence, the PLC will initiate a train shutdown. The operator can correct the failure, and then resume the start-up sequence from the current shutdown sequence step by pressing the "Train Start" pushbutton.

2.7.2 Shutdown Sequence

When in Semi-Automatic mode, the operator may implement the Shutdown Sequence at any time from the HMI or remotely. During shutdown, the HMI will display "Train Stopping".

The shutdown sequence automatically cycles through the steps listed below.

1. System Shutdown Initiated:
   a. Close the Influent Valve, Shutdown the Chemical Feed Pumps, Shutdown the mixers. Stop Water Polymer Carrier Solenoid valve.

2. Delay an (Operator Adjustable) (10-30 minutes):
   a. Shutdown the Scraper
   b. Start the Standby Sludge Pump

3. Delay 5 minutes:
   a. Shutdown the Duty Sludge Pump and Shutdown the standby Sludge Pump

NOTE: This delay allows purging of sludge contained in the settling tank and piping.

The operator can initiate the Train start-up sequence from the current shutdown sequence step by pressing the "Train Start" pushbutton without stopping the equipment already started.

2.8 ALARM/FAILURE CONDITIONS AND PLC RESPONSES

2.8.1 Alarm Priorities

Alarms are grouped in to 3 priority levels for various attention requirements:

Emergency alarms:

1. Needs immediate operator attention.
2. The MULTIFLO® unit will initiate the emergency shutdown of all equipment.

Fatal alarms:

1. Needs immediate operator attention.
2. The MULTIFLO® unit will initiate the shutdown sequence.

Warning alarms:

1. Does not need immediate operator attention.

If the MULTIFLO® unit was stopped by an Emergency alarm or Fatal alarm, it will not restart automatically. The operator must remove alarm condition and reset the alarm. Then press the start button on the operator interface will restart the unit if all automatic start sequence conditions are satisfied. In case of remote control, the system will wait for rising edge of the remote start signal.

2.8.2 Alarm and Set Point Table

Refer to the project Alarms and Setpoints Table.

2.9 SAFETY

2.9.1 Emergency Stop

Emergency stop actions

When an emergency stop button is activated, an alarm is triggered. The fault associated with this alarm will latch.

During emergency stop, many stopping actions are initiated on equipment. These actions are presented in sections describing the relevant equipment.

Recovery after emergency stop

When all emergency stop buttons are back into normal position, the fault associated with an alarm is maintained until the operator presses the reset button.

2.9.2 Control Power Failure PLC Response

Should control power fail at any time during Semi-Automatic control of the MULTIFLO® system, the PLC will issue an alarm and will initiate a Shutdown Sequence as described in this document. Systems with an Uninterruptable Power Supply (UPS) will see the alarm as the condition occurs. Systems without an UPS will see the alarm upon restoration of power. There is a ten (10) second delay upon restoring power, and then the train will enter the Shutdown Sequence as described in this document. If the restored power does not include the actual motor controls, a run status will not be received by the PLC and equipment (pumps and scraper) will shut down immediately without a re-inventory of the sludge to the maturation tank. If the unit is configured to resume via the HMI, it will automatically resume to the last known state. Otherwise the unit will remain in Stop.

2.10 CALCULATED PARAMETERS

The following sections explain the main calculations made in the control of the MULTIFLO® system.

The PLC calculates the chemical feed rates and controls the chemical metering pumps using the following procedure. The chemical feed rate is based on:

1. The influent raw water flow rate
2. The chemical dose
3. The physical properties of the chemicals
4. The capacity and settings of the metering pump

5. The raw water turbidity

The influent raw water flow rate is obtained through the raw water flow meter, which sends a signal to the PLC.

The influent raw water turbidity rate is obtained through the raw water turbidimeter and the raw water pH is obtained through the raw water pH meter if applicable.

The chemical dose, physical properties and metering pump capacity are input by the user/operator at the HMI.

The basic equation for the chemical feed rate is:

$$\text{Chemical feed rate} = \frac{\text{influent flow rate} \times \text{chemical dose}}{\text{stock chemical concentration}}$$

This equation is the general form for all chemical feed rates that use flow pacing control, including coagulant and polymer.

2.10.1 Flow Pace Control

The way the PLC uses these calculations to determine the chemical metering pump output is:

1. The chemical feed rate equations are programmed into the PLC.
2. The user/operator inputs the chemical dose, physical properties, and maximum chemical metering pump capacity at the HMI on the MULTIFLO® control panel. The PLC calculates the specific chemical feed rate based on the user/operator inputs and the influent (raw water) flow to the train.
3. The calculated feed rate is then converted by the PLC into a percent speed, based on the maximum capacity of the metering pumps. This signal is then sent to the metering pump.

2.10.2 Turbidity matrix

The turbidity matrix will vary the coagulant dosage set point according to the inlet TSS/Turbidity. A table completed by the user is used by the PLC to adapt the dosing rate. The user can enter up to 10 points in the table.

All TSS/Turbidity & dosage set point shall be adjustable.

AIT11-01 (TSS) reading		Coagulant dosage (mL/L)
Under	AIT0-011_SP1	Dosage #1
AIT11-01	& AIT11-01_SP2	Dosage #2
BetweenAIT11-01_SP2	&AIT11-01_SP3	Dosage #3
BetweenAIT11-01_SP3	&AIT11-01_SP4	Dosage #4
BetweenAIT11-01_SP4	&AIT11-01_SP5	Dosage #5
BetweenAIT11-01_SP5	&AIT11-01_SP6	Dosage #6
BetweenAIT11-01_SP6	&AIT11-01_SP7	Dosage #7
BetweenAIT11-01_SP7	&AIT11-01_SP8	Dosage #8
BetweenAIT11-01_SP8	&AIT11-01_SP9	Dosage #9
Over	AIT11-01_SP10	Dosage #10

If the raw water TSS/Turbidity measure is out of range, the flow pace control mode is forced. The last set point is applied.

2.11 INTERLOCKS

2.11.1 Multiflo® High Level Switch

A float over the settling tank is used as a High Level switch. When the switch is activated, stop the corresponding Multiflo® unit according to the automatic shutdown sequence.

2.11.2 Sludge pump Pressure (not applicable in this project)

When applicable, a pressure transmitter on pump discharge is installed to indicate the pressure and line clogging. When the low low or the high high pressure is reached, stop the sludge pump. The MULTIFLO® unit will initiate the emergency shutdown of all equipment.

2.11.3 High High Scraper Torque (cut-off)

The torque detector/alarm is independent from the PLC. So it is enabled (will stop the scraper) through a hardwired interlock to the scraper starter in the corresponding Multiflo® control panel.

A high high torque alarm is activated when the torque is higher than the adjustable set point for more than the adjustable delay. Those adjustable variables are set on the microcontroller or the dual pressure switch connected to a relay installed in the panel.

When the high high alarm is activated, the scraper is stopped and then the Multiflo® is stopped according to the automatic shutdown sequence.

2.11.4 Maturation Mixer

The maturation mixer cannot run if the scraper is not running.

2.11.5 Scraper

The scraper cannot run if at least one sludge pump is not running.

3 SYSTEM AND COMMUNICATION

The MULTIFLO® control panel PLC is capable of providing the following global statuses over the main plant PLC network: Global "Ready," and Global "Fail."

A Global "Ready" status indicates the system is ready to accept a Global "Start/Stop" command from the main plant PLC.

When the MULTIFLO® system receives a Global "Start" command, the Start-Up Sequence is initiated as described in section 2.7.1 above; this holds true for both Start-Up under normal conditions as well as for Start Up after a power failure.

When the MULTIFLO® system receives a Global "Stop" command under normal conditions, the Shutdown Sequence is initiated as described in section 2.7.2 above.

3.1 Hardwire Signals

The following electrical signals are used to communicate some information about the Multiflo trains:

Name	Type	Description	True
Start/Stop	DI	To Start/Stop the unit Remotely	Start the unit
Water Demand	DI	To require the production of water by the Multiflo	Start a production Sequence
Status - In Service	DO	Multiflo In Service Step	
Status - Alarm Active	DO	Warning or Fatal Alarm Active	

APPENDIX C

Coagulant dosing skid

Functional Description

COAGULANT DOSING SKID

PROCESS CONTROL DESCRIPTION

VEOLIA WATER TECHNOLOGIES CANADA

www.veoliawatertechnologies.com

REVISION STATUS

Issue	Date	Created	Reviewed	Approved	Description of Changes
1	2018/02/19	ED	GP/IL	XM	First Issue

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1 COAGULANT DOSING SYSTEM

1.1 Description

The coagulant dosing unit consists of the following control devices and instruments completely pre-piped and arranged on a skid as follows:

Table 1.1-1: Coagulant dosing system control devices

Project Tag No	Standard Tag No	Description
LSLL0411/LSLL0421	LSL51-01	COAG TANK LOW LOW LEVEL SWITCHS
65PME68001A	PC51-01	COAGULANT DOSING PUMP #1
65PME68001B	PC51-02	COAGULANT DOSING PUMP #2-BACKUP

1.2 Controls

1.2.1 General

The coagulant dosing skid consists of two coagulant dosing pumps with one duty and one standby.

The required dosage is entered on the operator interface. The program calculates the speed of the pump using the entered dosage.

1.2.2 Duty/Standby Rotation

The duty/Standby rotation of the pumps is manual. The operator selects on the interface the duty pump.

1.2.3 Calculations

The required dosing flow is function of the raw water flow and the required concentration (dosing rate).

Flowmeters used for calculation:

Coagulant dosage in the Injection Line to Multiflo will be proportional to the flowmeter FIT-0101 measure (Q_{INF1}).

The operator can enter the dosage inputs in mg/L or in µL/L.

Mode 1: RC_{COAG1} in mg/L

Equation 1: Coagulant flow rate calculation

$$QC_{COAG} = (RC_{coag1}) * (Q_{INF1}) / ((SG_{COAG}) * (CS_{COAG}) * 10)$$

Where:

QC_{COAG} = Required Coagulant Dosing Flowrate (L/h)

RC_{COAG1} = Required Chemicals Concentration in the process (mg/L)

Q_{INF1}= Influent Flowrate (m3/h)

SG_{COAG}= Chemical Specific Gravity (kg/L)

CS_{COAG}= Chemical stock concentration (%)

Mode 2: RC_{COAG2} in µL/L

Equation 2: Coagulant flow rate calculation

$$QC_{COAG} = (RC_{coag2}) * (Q_{INF1})$$

Where:

QC_{COAG} = Required Coagulant Dosing Flowrate (L/h)

RC_{COAG2} = Required Chemicals Concentration in the process (µL/L)

Q_{INF1} = Influent Flowrate (m3/h)

The calculation of the dosage percentage is done by integrating calibration values retrieved from each dosing pump. Two (2) verification points are required to scale the chemical flow rate in percentages for an adjusted pressure. The chemical flow rate verification is always done for two specific dosage percentage values, 20% and 80%.

The dosage percentage is given by:

Equation 3: Coagulant percentage calculation

$$(CD_{COAG}) = (60 \times ((QC_{COAG}) - (QC_{20\text{-}COAG})) / ((QC_{80\text{-}COAG}) - (QC_{20\text{-}COAG}))) + 20$$

Where:

CD_{COAG} = Coagulant Dosage Percentage (%)

QC_{coag} = Required Coagulant Dosing Flowrate (L/h)

QC_{20} = Measured Coagulant Dosing Flowrate at 20% of the calibration curve (L/h) (Entered by the operator on the interface).

QP_{80} = Measured Coagulant Dosing Flowrate at 80% of the calibration curve (L/h) (Entered by the operator on the interface).

The following parameters shall be available on the operator interface of the coagulant dosing system:

(**RC_{COAG1}**) Final concentration target in mg/L

(**RC_{COAG2}**) Final concentration target in µL/L

(**SG_{COAG}**) Density of the dosed solution in kg/L

(**CS_{COAG}**) Chemical concentration in the stock solution in %

(**$QC_{20\text{-}COAG}$**) Chemical flow rate at 20% dosage in L/h

(**$QC_{80\text{-}COAG}$**) Chemical flow rate at 80% dosage in L/h

1.2.4 Automatic Conditions

The coagulant dosage is started if at least one of the following conditions is true for a pump:

1. FIT 0101> 1 m^3/h
2. E-stop not activated

A metering pump may operate in manual mode at the pump local interface.

1.2.5 Major Fault response

In the case of dosing pumps supplied with their own level sensors, DEL indicators will display the status of pump and the level in the chemical storage tank:

DEL color	Pump state
Green display	No level sensor activated, pump runs.
Orange display	Low tank level (warning), pump continues to run
Red display	Empty tank, pump is interlocked and stopped.

These pumps can then send the status to PLC via 2 relays (warning and alarm).

The coagulant dosage is in major fault, if at least one of these faults is active:

1. Two coagulant dosing pumps in fault (one duty and its backup).
2. The low low level switch in the coagulant tank is activated

When a coagulant pump faults, a message is displayed and the back-up pump starts.
If the second pump faults, an alarm is activated.

Sequence of event when the alarm is tripped:
1. Stop the coagulant dosing pump;
2. Stop the Multiflo® according to the automatic stop sequence.

1.2.6 Dosing pump out of capacity alarm

These alarms show that the required chemical flow is out of the dosing pump range for the adjusted stroke length.

1.2.6.1 Maximum coagulant flow alarm

A message is displayed on operator interface if the pump speed exceeds the maximum speed setpoint. Operator must adjust stroke of the pump if available. This alarm is not latched.

1.2.6.2 Minimum coagulant flow alarm

A message is displayed on operator interface if the pump speed is below the minimum speed setpoint. Operator must adjust stroke of the pump if available. This alarm is not latched.

1.2.7 Interlocks

1.2.7.1 Coagulant tank low low level

If the low low level switch in the coagulant storage tank is activated, it interlocks the coagulant dosing pumps. Interlock is active in automatic mode and interface manual mode.

APPENDIX D

Polymer preparation system

Functional Description

POLYMER PREPARATION SYSTEM

PROCESS CONTROL DESCRIPTION

VEOLIA WATER TECHNOLOGIES CANADA
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Issue	Date	Created	Reviewed	Approved	Description of Changes
1	2018/01/26	ED	GP	JK	First Issue
2	2019-02-28		MD	GP	Second issue

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1 Automatic Polymer Preparation System

1.1 Description

The Hydrapol 500 is an automatic machine for batch preparation of polymer solutions. A screw doses dry polymer powder into a cone, and then service water wets it in a water whirl. The mixture is discharged into a maturation tank where an agitator agitates the solution during a period of 60 -90 minutes. After this period the solution is transferred into a storage tank.

The automatic polymer preparation system consists of the following control devices and instruments completely pre-piped and arranged on the same skid as the polymer dosing system:

Table 1.1-1: Polymer preparation system control devices

Project Tag No	Standard Tag No	Description
ND62-03	ND62-03	DRY POLYMER VACUUM – POLYMER PREPARATION
ND62-01	ND62-01	FEEDER SCREW MOTOR
PSLL62-01	PSLL62-01	PRESSURE SWITCH - POLYMER PREPARATION
LSL0232	LSLL62-01	LOW LEVEL SWITCH – POLYMER PREPARATION
VE62-02	VE62-02	4-WAY SOLENOID VALVE – POLYMER PREPARATION
VE62-01	VE62-01	SOLENOID VALVE - POLYMER PREPARATION
VA62-01	VA62-01	TRANSFER VALVE - POLYMER PREPARATION
LT62-01	LT62-01	LEVEL TRANSMITTER - POLYMER MATURATION TANK
AG62-01	AG62-01	MIXING TANK AGITATOR
LT62-02	LT62-02	LEVEL TRANSMITTER - POLYMER STORAGE TANK

1.2 Controls

1.2.1 General

The polymer preparation is controlled by the preparation and transfer sequence outlined in the section 1.2.5. If equipment involved in the sequence faults during the sequence, an alarm is displayed on the operator interface and the operator must fix the problem and then manually start the sequence again. If this occurs the sequence will pick up where it left off unless otherwise indicated.

1.2.2 Calculations

Powder polymer is injected into a preparation tank using a dosing apparatus. The apparatus operating time is calculated based on its capacity and the desired concentration.

Dosage calculation

The operating dosing time is calculated based with the following formula:

$$Ts = \frac{CONC \times ((LEVstop - LEV) \times Surf)}{Cap} \times 60$$

Ts:	Dosing apparatus operating time (sec.)
CONC:	Polymer concentration adjustable to operator interface (g/l)
LEV:	Preparation tank's current level (m)
LEVstop:	Preparation stop level set point (m)
Surf:	Preparation tank surface (m^2)
Cap:	Dosing apparatus capacity adjustable to operator interface (Kg/min)

Note: This formula may also be used to perform a manual preparation in case of automatic system failure. To ensure dosing accuracy of the tank, capacity must be validated by the operator.

1.2.3 Automatic Conditions

1.2.4 Conditions for automatic Start sequence

The automatic start sequence will be activated when the automatic start command is true and the following conditions are met:

1. If delay for power return is elapsed;
2. If remote run request bit is activated;
3. Polymer preparation system components are in Auto start mode.

1.2.5 Automatic start sequence

The automatic preparation system shall follow a given sequence to ensure a consistent polymer solution. The preparation sequence is described in the following table:

Step #	Step name	Actions Transition conditions	Polymer mixer	Dosing screw	Service water valve	Powder supply valve	Transfer valve
0	Stand-by	Equipment shut off	S	S	C	C	C
		-Preparation tank level set point for start of reached sequence -Transfer valve closed for 30 seconds if no confirmation of closure or when confirmation of closure is received.					
1	Filling	-Remove completed preparation confirmation -Open preparation water valve	S	S	O	C	C
		Level above impeller					
2	Start mixing	Start preparation mixer	R	S	O	C	C
		- Mixer running confirmation - 10 second delay has elapsed					
3	Dosing	-Supply valve opened (if Dost not reached) -Start dosing apparatus (if Dost not reached)	R	R	O	O	C
		Dosing time elapsed (Dost) (retentive dosing timer) or High level in preparation tank					
4	Stop dosing	-Stop powder supply screw -Close powder supply valve	R	S	O	C	C
		Filling stop level					
5	Maturation	Close preparation water valve Start of maturation period	R	S	C	C	C
		Time elapsed 30–180 adjustable minutes (Retentive maturation delay)					
6	End	-Completed preparation confirmation	R	S	C	C	C
		Go to Step 0 at end of normal sequence and reset timers -Go to Step 7 at end of sequence by a fault					
7	**Sequence stopped on a fault**	- Wait for fault reset	S	S	C	C	C
		-Go to Step 1					

Legend

Motor	***Valve***
S: Stop	*C: Closed*
R: Running	*O: Open*

Table 1.2-1: Polymer Preparation Sequence

Note: if there is a power outage before the completed preparation confirmation is active, repeat at Step 1 when the power returns.

1.2.6 Transfer from preparation tank to storage tank

When the storage tank level reaches the transfer set point, and the completed preparation confirmation is active, the transfer valve opens until the preparation tank level set point for the start of the next sequence is reached.

Note: if there is a power outage when the transfer is underway, continue the transfer from where it was.

1.3 Fault response

The faults associated with the polymer makeup sequence are:

- Polymer feeder fault ND62-01
- LSLL62-01
- PSLL62-01
- Transfer (VA62-01)and water valve (VE62-01) open/close fault
- LT fault (LT62-01/ LT62-02)
- Low level storage tank (LT62-02 Low low level alarm)
- Agitator AG62-01 fault

Polymer feeder fault
Tag: ND62-01
The feeder and blending tool stop, polymer preparation system falls on fault and polymer sequence is stopped until the problem is fixed.

Transfer and water valve open/close fault
Tag: VA62-01/ VE62-01)
Polymer preparation system falls on fault and polymer sequence is stopped until the problem is fixed.

Low powder level
Tag: LSLL62-01
Polymer preparation system continues but next batch is prevented from starting, an alarm is displayed and polymer sequence is stopped until the problem is fixed.

Low preparation water pressure
Tag: PSLL62-01
Polymer preparation system falls on fault and polymer sequence is stopped until the problem is fixed.

LT Fault
Tag: LT62-01/ LT62-02
Transfer from mixing tank is prohibited, polymer preparation system falls on fault and polymer sequence is stopped until the problem is fixed

Agitator fault
Tag: AG62-01
Agitator stops, polymer preparation system falls on fault and polymer sequence is stopped until the problem is fixed.

Low level storage tank
Tag:LT62-02
The polymer pumps are stopped, polymer preparation system falls on fault and polymer sequence is stopped until the problem is fixed.

High level storage tank
Tag: LT62-02
Transfer from mixing tank is prohibited, polymer preparation system falls on fault and polymer sequence is stopped until the problem is fixed.

APPENDIX E

Polymer dosing skid

Functional Description

POLYMER DOSING SKID

PROCESS CONTROL DESCRIPTION

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1	2018/01/26	ED	GP	JK	First Issue

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1 INTRODUCTION

1.1 Reference Documents

Document Number	Name	Revision
5000219003_PI_0001_GEN_VWT	PI001 _Process and Instrumentation diagram	1

1.2 Process Overview

The polymer is metered proportional to the raw water flow. Four dosing points can be selected manually by the operator on Multiflo® unit. The polymer dosing unit consists of the following control devices and instruments completely pre-piped and arranged on a skid as follows:

Table 1.2-1: Polymer dosing system control devices

Project Tag No	Standard tag No	Description
FV0466	SV52-01	ON/OFF VALVES - CARRIER WATER MULTIFLO
65PME68002A	PC52-01	POLYMER DOSING PUMP #1 - MULTIFLO
65PME68002A	PC52-01	POLYMER DOSING PUMP #2 -BACKUP
TSH0451	TSH52-01	POLYMER DOSING PUMP #1 – TEMPERATURE SWITCH
TSH0461	TSH52-02	POLYMER DOSING PUMP #2 – TEMPERATURE SWITCH

1.3 Control Description

There are two polymer dosing pumps (one duty/one standby) per skid. A speed signal is sent to each pump. The dedicated water transport solenoid valve is open if a command is received from the Multiflo operation sequence. The metering is done by entering the required dosage on the operator interface. The PLC will calculate the speed of the pump using the entered dosage and the actual water flow.
The duty pump is selectable by the operator on the interface.

1.3.1 Calculations

The required dosing flow (QP) is a function of the water flow (Q_{INF1}), required concentration (CF), chemical stock concentration (CP), chemical specific gravity (DS) and water transport flowrate (QE) (see figure below). In neglecting the chemical flow rate (QP) and the water transport flow rate (QE) in the (QF) equation, the final output flow rate (QF) will be equal to (Q_{INF1}).

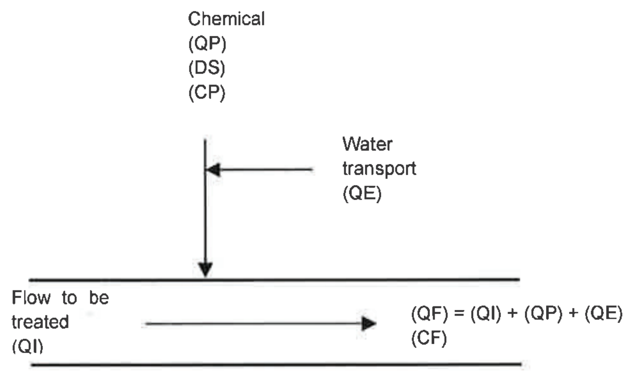

Figure 1.3-1 : Polymer Injection

The chemical flow rate (QP) is given by:

Equation 1 : Polymer flowrate calculation

$$(QP_{PPD}) = (CF_{PPD}) * (Q_{INF1}) / ((SG_{PPD}) * (CP_{PPD}) * 10)$$

Where:
QP_{PPD} = Required Polymer Dosing Flowrate (L/h)
CF_{PPD} = Required Chemicals Concentration in the process (mg/L)
Q_{INF1} = Raw Water Flowrate (m3/h). Process Value given by the water flowmeters
SG_{PPD}= Chemical Specific Gravity (kg/L)
CP_{PPD}= Chemical stock concentration (%)

The calculation of the dosage percentage is done by integrating calibration values retrieved from the dosing pump. Two (2) verification points are required to scale the chemical flow rate in percentage for an adjusted pressure. The chemical flow rate verification is always done for two specific dosage percentage values, 20% and 80%.

The dosage percentage is given by:

Equation 2 : Polymer percentage calculation

$$(PO) = (60 \times ((QP_{PPD}) - (QP_{PPD20})) / ((QP_{PPD80}) - (QP_{PPD20}))) + 20$$

Where :

PO = Polymer Dosage Percentage (%)
QP_{PPD} = Required Polymer Dosing Flowrate (L/h)
QP_{PPD20} = Measured Polymer Dosing Flowrate at 20% of the calibration curve (L/h) (Entered by the operator on the interface).
QP_{PPD80} = Measured Polymer Dosing Flowrate at 80% of the calibration curve (L/h) (Entered by the operator on the interface).

<u>The following parameters shall be available on the operator interface of the polymer dosing system :</u>

1. (**CF_{PPD}**) Required Chemicals Concentration in the process in mg/l
2. (**SG_{PPD}**) Density of the dosed solution in kg/l
3. (**CP_{PPD}**) Chemical concentration in the dosed solution in %
4. (**QP_{PPD20}**) Chemical flow rate at 20% dosage in l/h
5. (**QP_{PPD80}**) Chemical flow rate at 80% dosage in l/h
6. **(PO_L)** Low dosing percentage threshold in %
7. **(PO_H)** High dosing percentage threshold in %

1.3.2 Valves

Carrier water is necessary to dilute quickly the polymer in the Multiflo unit.
The Carrier Water Solenoid Valves are an on/off device, they are open during the Multiflo Start sequence and stop by the Multiflo stop sequence.

The carrier water valve SV52-01 is open if the Polymer Pump PC52-01 or PC52-02 is running in automatic mode.

1.3.3 Availability Conditions

1.3.3.1 Stop Conditions

Polymer dosage stop
The polymer dosage is stopped and the dosage percentage (PO) is forced to zero, if at least one of the following conditions is true:

1. The Multiflo® is not running ;
2. The polymer dosage in major fault;

1.3.4 Fault Response

The polymer dosage is in major fault, if at least one of these faults is active:

1. Polymer storage tank low low level ;
2. Both polymer dosing pumps fault.

Polymer pump Fault

When a polymer pump faults, a message is displayed and the back-up pump starts.

If the second pump faults, an alarm is activated.

Sequence of event when the alarm is tripped:

1. Stop the polymer dosing pump;
2. Stop service water
3. Stop the Multiflo® according to the automatic stop sequence;

Dosing pump out of capacity alarm

These alarms show that the required chemical flow is out of the dosing pump range.

Polymer pump low dosing capacity

If (PO) < (PO_L) and the pump is running in auto for a period of 60 sec, an alarm will be displayed on the operator interface to inform the operator that the dosing capacity of the pump is low.

Note: The low dosing percentage threshold (POL) is lower than 5 %.

Alarm is activated.

Polymer pump high dosing capacity

If (PO) > (PO_H) and the pump is running in auto for a period of 60 sec, an alarm will be displayed on the operator interface to inform the operator that the dosing capacity of the pump is high.

Note: The high dosing percentage threshold (PO_H) is higher than 95 %

Alarm is activated.

Polymer Dosing Pump – High temperature alarm

The polymer dosing pump are equipped with a high temperature switch

When this switch is activated then:

1. Pump stops and an alarm is activated.
2. Back-up pump starts.

Sequence of event when the two temperature switches are tripped:

1. Stop the polymer dosing pumps;
2. Stop service water
3. Stop the Multiflo® according to the automatic stop sequence.

1.3.5 Interlocks

Carrier Water Valve
The valve will be closed by interlock if:
1. If corresponding Multiflo® unit High High switch alarm

Interlock is active in automatic or interface manual mode.

Polymer storage tank low low level
All the polymer pumps are prevented to start or are stopped by interlock if:
1. Polymer storage tank low low level alarm is activated

Interlock is active in automatic or interface manual mode.

APPENDIX F

Alkali dosing skid

Functional Description

ALKALI DOSING SKID

PROCESS CONTROL DESCRIPTION

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1 ALKALI DOSING SYSTEM

1.1 DESCRIPTION

The alkali dosing unit consists of the following control devices and instruments completely pre-piped and arranged on a skid as follows:

Table 1.1-1: Alkali dosing system control devices

Project Tag No	Standard Tag No	Description
LSLL0511/LSLL0521	LSL51-01	ALKALI TANK LOW LOW LEVEL SWITCH
65PME68003A	PC54-01	ALKALI DOSING PUMP #1
65PME68003B	PC54-02	ALKALI DOSING PUMP #2-BACKUP

1.2 CONTROLS

1.2.1 General

The alkali dosing skid consists of two alkali dosing pumps with one duty and one standby.

The required dosage is entered on the operator interface. The program calculates the speed of the pump using the entered dosage.

1.2.2 Duty/Standby Rotation

The duty/Standby rotation of the pumps is manual. The operator selects on the interface the duty pump.

1.2.3 Calculations

The required dosing flow is function of the raw water flow and the required concentration (dosing rate).

Flowmeters used for calculation:

Alkali dosage in the Injection Line to chlorination tank will be proportional to flowrate Q_{INF2} =flowmeters FIT-0101 – FIT0128 measures.

The operator can enter the dosage inputs in mg/L or in µL/L.

Mode 1: RC_{AKLA1} in mg/L

Equation 1: Alkali flow rate calculation

$$QC_{ALKA} = (RC_{ALKA1}) * (Q_{INF2}) / ((SG_{ALKA}) * (CS_{ALKA}) * 10)$$

Where:

QC_{ALKA} = Required Alkali Dosing Flowrate (L/h)

RC_{ALKA1} = Required Chemicals Concentration in the process (mg/L)

Q_{INF2}= Calculated Influent Flowrate (m3/h)

SG_{ALKA}= Chemical Specific Gravity (kg/L)

CS_{ALKA}= Chemical stock concentration (%)

Mode 2: RC_{ALKA2} in µL/L

Equation 2: Alkali flow rate calculation

$$QC_{ALKA} = (RC_{ALKA2}) * (Q_{INF2})$$

Where:

QC_{ALKA} = Required Alkali Dosing Flowrate (L/h)

RC_{ALKA2} = Required Chemicals Concentration in the process (µL/L)

Q_{INF2} = Influent Flowrate (m3/h)

The calculation of the dosage percentage is done by integrating calibration values retrieved from each dosing pump. Two (2) verification points are required to scale the chemical flow rate in percentages for an adjusted pressure. The chemical flow rate verification is always done for two specific dosage percentage values, 20% and 80%.

The dosage percentage is given by:

Equation 32: Alkali percentage calculation

$$(CD_{ALKA}) = (60 \times ((QC_{ALKA}) - (QC_{20\text{-}ALKA})) / ((QC_{80\text{-}ALKA}) - (QC_{20\text{-}ALKA}))) + 20$$

Where:

$\mathbf{CD_{ALKA}}$ = Alkali Dosage Percentage (%)

$\mathbf{QC_{ALKA}}$ = Required Alkali Dosing Flowrate (L/h)

$\mathbf{QC_{20}}$ = Measured Alkali Dosing Flowrate at 20% of the calibration curve (L/h) (Entered by the operator on the interface).

$\mathbf{QP_{80}}$ = Measured Alkali Dosing Flowrate at 80% of the calibration curve (L/h) (Entered by the operator on the interface).

<u>The following parameters shall be available on the operator interface of the alkali dosing system:</u>

(RC_{ALKA1}) Final concentration target in mg/L

(RC_{ALKA2}) Final concentration target in µL/L

($\mathbf{SG_{ALKA}}$) Density of the dosed solution in kg/L

($\mathbf{CS_{ALKA}}$) Chemical concentration in the stock solution in %

($\mathbf{QC_{20\text{-}ALKA}}$) Chemical flow rate at 20% dosage in L/h

($\mathbf{QC_{80\text{-}ALKA}}$) Chemical flow rate at 80% dosage in L/h

1.2.4 Automatic Conditions

The alkali dosage is started if at least one of the following conditions is true for a pump:

1. $Q_{INF2} > 1$ m³/h
2. E-stop not activated

A metering pump may operate in manual mode at the pump local interface.

1.2.5 Major Fault response

In the case of dosing pumps supplied with their own level sensors, DEL indicators will display the status of pump and the level in the chemical storage tank:

DEL color	Pump state
Green display	No level sensor activated, pump runs.
Orange display	Low tank level (warning), pump continues to run
Red display	Empty tank, pump is interlocked and stopped.

These pumps can then send the status to PLC via 2 relays (warning and alarm).

The alkali dosage is in major fault, if at least one of these faults is active:

1. Two alkali dosing pumps in fault (one duty and its backup).
2. The low low level switch in the alkali tank is activated

When an alkali pump faults, a message is displayed and the back-up pump starts.
If the second pump faults, an alarm is activated.

Sequence of event when the alarm is tripped:
1. Stop the alkali dosing pump;
2. Stop the Multiflo® according to the automatic stop sequence.

1.2.6 Dosing pump out of capacity alarm

These alarms show that the required chemical flow is out of the dosing pump range for the adjusted stroke length.

1.2.6.1 Maximum alkali flow alarm

A message is displayed on operator interface if the pump speed exceeds the maximum speed setpoint. Operator must adjust stroke of the pump if available. This alarm is not latched.

1.2.6.2 Minimum alkali flow alarm

A message is displayed on operator interface if the pump speed is below the minimum speed setpoint. Operator must adjust stroke of the pump if available. This alarm is not latched.

1.2.7 Interlocks

1.2.7.1 Alkali tank low low level

If the low low level switch in the alkali storage tank is activated, it interlocks the alkali dosing pumps. Interlock is active in automatic mode and interface manual mode.

1.2.7.2 Chlorination tank high high pH

If the high high pH alarm in the chlorination tank is activated, it interlocks the alkali dosing pumps. Interlock is active in automatic mode and interface manual mode. This alarm is an auto reset after an adjustable delay to prevent pump start when pH is lower than the high alarm value.

1.2.7.3 Mixing pumps fault or not running

If the mixing pumps are not in operation, the alkali dosing pumps are interlocked.

APPENDIX G

Hypochlorite dosing skid

Functional Description

CALCIUM HYPOCHLORITE DOSING SKID

PROCESS CONTROL DESCRIPTION

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1 CALCIUM HYPOCHLORITE DOSING SYSTEM

1.1 DESCRIPTION

The calcium hypochlorite dosing unit consists of the following control devices and instruments completely pre-piped and arranged on a skid as follows:

Table 1.1-1: Calcium hypochlorite dosing system control devices

Project Tag No	Standard Tag No	Description
N/A	LSL85-01	CALCIUM HYPOCHLORITE TANK LOW LOW LEVEL SWITCH
65PME68004A	PC53-01	CALCIUM HYPOCHLORITE DOSING PUMP #1
65PME68004B	PC53-02	CALCIUM HYPOCHLORITE DOSING PUMP #2

1.2 CONTROLS

1.2.1 General

The calcium hypochlorite dosing skid consists of two calcium hypochlorite dosing pumps with one duty and one standby.

The required dosage is entered on the operator interface. The program calculates the speed of the pump using the entered dosage.

1.2.2 Duty/Standby Rotation

The duty/Standby rotation of the pumps is manual. The operator selects on the interface the duty pump.

1.2.3 Calculations

The required dosing flow is function of the inlet flow and the required concentration (dosing rate).

Flowmeters used for calculation:

Calcium hypochlorite dosage in the Injection Line to chlorination tank will be proportional to the flowrate setpoint Q_{INF2} =flowmeters FIT-0101 – FIT0128 measures.

The operator can enter the dosage inputs in mg/L.

Mode : **RC_{Hypo}** in mg/L

Equation 1: Calcium hypochlorite flow rate calculation

$$QC_{HYPO} = (RC_{HYPO}) * (Q_{INF2}) / ((SG_{HYPO}) * (CS_{HYPO}) * 10)$$

Where:

QC_{HYPO} = Required Calcium hypochlorite Dosing Flowrate (L/h)

RC_{HYPO} = Required Chemicals Concentration in the process (mg/L)

Q_{INF2}= Influent Flowrate (m3/h)

SG_{HYPO}= Chemical Specific Gravity (kg/L)

CS_{HYPO}= Chemical stock concentration (%)

The calculation of the dosage percentage is done by integrating calibration values retrieved from each dosing pump. Two (2) verification points are required to scale the chemical flow rate in percentages for an adjusted pressure. The chemical flow rate verification is always done for two specific dosage percentage values, 20% and 80%.

The dosage percentage is given by:

Equation 2: Calcium hypochlorite percentage calculation

$$(CD_{HYPO}) = (60 \times ((QC_{HYPO}) - (QC_{20\text{-}HYPO})) / ((QC_{80\text{-}HYPO}) - (QC_{20\text{-}HYPO}))) + 20$$

Where:

CD_{HYPO} = Calcium hypochlorite Dosage Percentage (%)

QC_{HYPO} = Required Calcium hypochlorite Dosing Flowrate (L/h)

QC_{20} = Measured Calcium hypochlorite Dosing Flowrate at 20% of the calibration curve (L/h) (Entered by the operator on the interface).

QP_{80} = Measured Calcium hypochlorite Dosing Flowrate at 80% of the calibration curve (L/h) (Entered by the operator on the interface).

The following parameters shall be available on the operator interface of the calcium hypochlorite dosing system:

(**RC_{HYPO}**) Final concentration target in mg/L

(**SG_{HYPO}**) Density of the dosed solution in kg/L

(**CS_{HYPO}**) Chemical concentration in the stock solution in %

(**$QC_{20\text{-}HYPO}$**) Chemical flow rate at 20% dosage in L/h

(**$QC_{80\text{-}HYPO}$**) Chemical flow rate at 80% dosage in L/h

1.2.4 Automatic Conditions

The calcium hypochlorite dosage is started if at least one of the following conditions is true for a pump:

1. $Q_{INF2} > 1\ m^3/h$
2. E-stop not activated

A metering pump may operate in manual mode at the pump local interface.

1.2.5 Major Fault response

The calcium hypochlorite dosage is in major fault, if at least one of these faults is active:

1. Two calcium hypochlorite dosing pumps in fault (one duty and one standby).
2. The low low level switch in the calcium hypochlorite tank is activated (TBC)

When a hypochlorite pump faults, a message is displayed and the standby pump starts. If the second pump faults, an alarm is activated.

Sequence of event when the alarm is tripped:

1. Stop the hypochlorite dosing pump;
2. Stop the Multiflo® according to the automatic stop sequence.

1.2.6 Dosing pump out of capacity alarm

These alarms show that the required chemical flow is out of the dosing pump range for the adjusted stroke length.

1.2.6.1 Maximum calcium hypochlorite flow alarm

A message is displayed on operator interface if the pump speed exceeds the maximum speed setpoint. Operator must adjust stroke of the pump if available. This alarm is not latched.

1.2.6.2 Minimum calcium hypochlorite flow alarm

A message is displayed on operator interface if the pump speed is below the minimum speed setpoint. Operator must adjust stroke of the pump if available. This alarm is not latched.

1.2.7 Interlocks

1.2.7.1 Calcium hypochlorite tank low low level (TBC)

If the low low level switch in the calcium hypochlorite storage tank is activated, it interlocks the calcium hypochlorite dosing pumps. Interlock is active in automatic mode and interface manual mode.